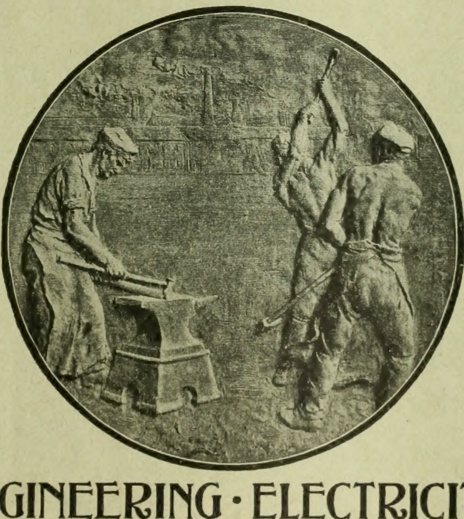
No. 73. Vol. 8.

SIXPENCE.
(Registered as a Newspaper.)

FRIDAY,
FEBRUARY 2, 1906.

PAGE'S WEEKLY



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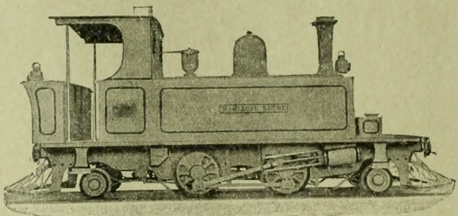
Of all sizes and any gauge of Railway, of greatly improved Construction, for Main or Branch Railways, Contractors, Ironworks, Collieries. Prices, Photographs, and full Specifications on application.



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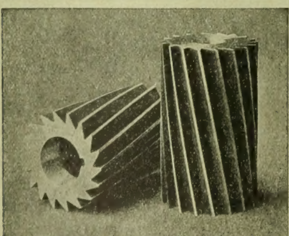

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IN EVERY SIZE FOR HAND OR POWER USE

HACK SAW BLADES

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The Sole Product of a Factory.

Best English Steel throughout

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PAGE'S WEEKLY Miscellaneous

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Consulting and Organising Engineer for Water Works and Industrial Undertakings,

19, OLD QUEEN ST., WESTMINSTER, S.W.
Telephone No.: 5754 Bank. Write for particulars.

A. MOUNT-HAES,

M.I.Mech.E., M.I.M.E.,

Consulting and Mining Engineer for Ore Dressing Plants of All Classes.

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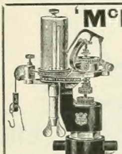
Tel. Address: "DRESSINGS, LONDON." Telephone No.: 272 Central.

PATENTS.

Mr. J. G. LORRAIN, M.I.E.E., M.I.Mech.E., Fellow of the Chartered Institute of Patent Agents.
NORFOLK HOUSE, NORFOLK STREET, STRAND, LONDON, W.C.
"PATENTEES' HANDBOOK," post free on application, gives Full Information to Inventors and upon all the chief points of the Patent Law.
Telegrams: "Lorrain, London."



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In Two types: External and Enclosed Pressure Springs.
Each made in several forms and sizes to suit all speeds and pressures.
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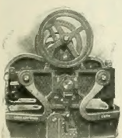

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PATENT WATER-TUBE BOILERS.

These Boilers are in use throughout the world to the extent of 4,700,000 h.p., generating steam for all purposes, and fired with all kinds of fuel.
See our Advertisement appearing Feb. 16th, page 37.
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WORKS—Renfrew, SCOTLAND.

NEW BOILERS

READY FOR PROMPT DELIVERY.

	Size.	Working Pressure.
One Thompson Boiler,	30 ft. by 8 ft. 6 in.	for 160 lb.
Three ,, ,,	30 ft. ,, 8 ft. 6 in.	,, 120 lb.
One ,, ,,	30 ft. ,, 8 ft. 6 in.	,, 100 lb.
Three ,, ,,	30 ft. ,, 8 ft.	,, 120 lb.
Six ,, ,,	30 ft. ,, 8 ft.	,, 100 lb.
One ,, ,,	28 ft. ,, 7 ft.	,, 140 lb.
One Cornish ,,	20 ft. ,, 5 ft.	,, 100 lb.

All sizes of Vertical Boilers from 2 to 20 n.h.p.

JOHN THOMPSON, Wolverhampton.

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Firewood Splitting and Bundling Machines.

Does 100 Men's Work. Old Timber utilised.
1½ to 3 tons per hour.

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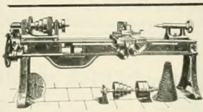

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PAGE'S WEEKLY Miscellaneous

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WIRE. 'Phone 958 Victoria

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Rolled Steel Joists, Channels, etc.

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CELLULOID SLIDE RULES.

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Piece Work, Balance and Premium Calculator.

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JOHN DAVIS & SON (Derby), LTD.

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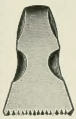

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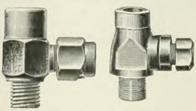

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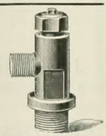

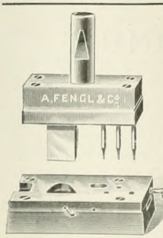

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PAGE'S WEEKLY Miscellaneous

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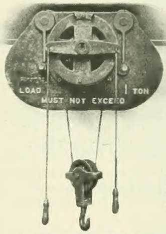

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For 5 and 10 cwts., and 1, 2, and 3 tons.

Portable Electrical Drilling Equipments and Flexible Shafts.

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Steel Chimneys.

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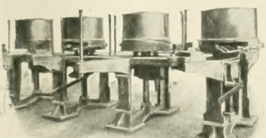

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SHONE PNEUMATIC EJECTORS

FOR RAISING SEWAGE, SLUDGE, WATER, &c.

Air Compressing Machinery

FOR ALL SERVICES.

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16, VICTORIA STREET, LONDON, S.W.

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Speciality—

FORGING PLANT.

See our Advertisement appearing Feb. 16th.
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Hack Saw Blades

"H. G. T."

(High Grade Throughout.)

Proved BEST by Independent TEST.

Lists and Samples Free.

BEANLAND, PERKIN & Co.,

2 to 8, Neville Street, LEEDS.

PAGE'S WEEKLY Contracts

CONTRACTS.

PONTYPRIDD URBAN DISTRICT COUNCIL.

ELECTRIC LIGHT AND TRAMWAYS DEPARTMENT.

The above Council invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of ONE 300-kilowatt STEAM DYNAMO.

Copies of the General Conditions, Specification, and Form of Tender, prepared by Mr. J. E. Teasde', A.M.I.E.E., Engineer and Manager, may be obtained on and after January 24th, 1906, upon receipt by the undersigned of a deposit of £2 2s., which will, after the Council shall have entered into a contract upon the Tenders received, be returned to the Tenderer, provided that he shall have sent in a *bona fide* Tender, and shall not have withdrawn the same.

Tenders, on the prescribed form, sealed, and endorsed "Tender for Steam Dynamo," must be received by the undersigned on or before FEBRUARY 13th, 1906.

The Council do not bind themselves to accept the lowest or any Tender.

J. COLENSO JONES,
Clerk to the Council.

District Council Offices, Pontypridd, January 15th, 1906.

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED,

is prepared to receive TENDERS for the SUPPLY of

21 LOCOMOTIVES with TENDERS (mixed Passenger and Goods).

Specifications and Forms of Tender may be obtained at the Company's offices.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Locomotives," must be left with the undersigned not later than 12 o'clock noon of Tuesday, February 6th, 1906.

The Company is not bound to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £2 for each copy of the specification.

The drawings may be inspected at the office of Sir George B. Bruce, 3, Victoria Street, Westminster.

By order, HENRY W. NOTMAN,
Managing Director.

Company's Offices:
55, Gracechurch Street, London,
January 19th, 1906.

SUPPLY AND ERECTION OF A REFUSE DESTRUCTOR.

TENDERS are invited by the Municipality of Pretoria, Transvaal, for the SUPPLY and ERECTION of a REFUSE DESTRUCTOR, capable of treating 60 tons of refuse per diem.

Tender Forms, Specification of the Destructor, Dimensions, and Levels of the Site upon which it will be erected, may be obtained on application to the Town Engineer, Pretoria, or at the office of Messrs. MOSENTHAL, SONS, AND CO., 72, Basinghall Street, London, E.C.

The successful tenderer will be required to pay to workmen employed on the erection of the above works wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in a list to be seen at the office of Messrs. MOSENTHAL, SONS, AND CO.; such rates of wages and hours of labour will form part of the contract to be entered into by the successful tenderer.

Tenders, enclosed in sealed envelopes, and endorsed "Tenders for Supply and Erection of Refuse Destructor at Pretoria," must reach the undersigned not later than March 15th, 1906, or the Town Clerk, Pretoria, not later than noon on April 6th, 1906.

The lowest or any Tender will not necessarily be accepted.

MOSENTHAL, SONS, AND CO.,
Representing Municipality of Pretoria.

COUNTY BOROUGH OF WOLVERHAMPTON.

TO WIRE ROPEWAY CONTRACTORS.

The Corporation of Wolverhampton are prepared to receive TENDERS for the MANUFACTURE, DELIVERY, and ERECTION of an AERIAL ROPEWAY, approximately 1300 yards in length, and other works incidental thereto, from Contractors who pay to the whole of their workmen such rate of wages and observe such hours of labour as are recognised by the Workmen's Trade Unions and the Associations of Employers in the several localities where their work is done.

A Copy of the Specification and Form of Tender may be obtained from Mr. E. A. B. WOODWARD, Waterworks Engineer, Town Hall, Wolverhampton, upon payment by P.O.O. of the sum of £2 2s., which amount will be refunded to each Contractor who submits a *bona fide* Tender.

Each Tender must be enclosed in a sealed cover addressed to "The Chairman of the Water Committee," and endorsed "Ropeway," and delivered at my office before 10 a.m. on Monday, the 5th day of February next.

The right to decline the lowest or any Tender is reserved to the Corporation.

HORATIO BREVITT,
Town Clerk.

Town Hall, Wolverhampton,
16th January, 1906.

RIVER WEAVER NAVIGATION.

TENDER FOR STORES.

The WEAVER TRUSTEES are prepared to receive TENDERS for the SUPPLY of all or any of the FOLLOWING MATERIALS for the Maintenance of the River from April 1st, 1906, to March 31st, 1907:

1. Leather Belting, Indiarubber, and Canvas Goods.
2. Building Materials (except timber).
3. Oils and Grease, both for illuminating and lubricating purposes: Candles, Paints, Varnishes, and Accessories, including Black Varnish.
4. Ironmongery, including Waste, Spades, Steam-Piping, Nails, Brushes, and General Stores.
5. Iron and Steel Bars, Angles, and Plates (except special boiler plates).
6. Cast Steel, Files, &c.
7. Bolts and Nuts, Bolt-Ends, Washers, Rivets, and Stud Iron.
8. Ropes, Twines, Cork Fenders, Hemp Packing, and Oakum.
9. Steam Coal, House Coal, and Gas Coke.

Schedules of approximate Quantities and Specifications may be obtained (on payment of One Guinea, which will be returned on receipt of a *bona fide* Tender) at the Engineer's Office, Northwich, on and after Monday, January 22nd, and all Tenders and Samples must be sent in, addressed to the "Chairman of the Stores Committee, care of the Clerk, Weaver Navigation Office, Northwich," before 9 a.m., on MONDAY, February 12th, 1906.

The Trustees do not bind themselves to accept the lowest or any Tender, and may, if they think fit, where the Tender includes a number of different Articles, accept only portions of such Tender.

Application for Tender Forms to be addressed

J. A. SANER, M.Inst. C.E.,
Engineer.

Weaver Navigation, Northwich.

THE ASSAM-BENGAL RAILWAY COMPANY, LIMITED,

is prepared to receive TENDERS for—

GIRDER BRIDGES.

Specifications and Tender forms may be obtained at the Offices of the Company, Bishopsgate House, 56, Bishopsgate Street Within, London, E.C.

A fee of 10s. 6d. is charged for each Specification, which cannot, under any circumstances, be returned.

Drawings may be had at the cost of the tenderer by application to Mr. F. Bennett, 6, Bond Court, Walbrook, E.C.

Tenders must be delivered at the Company's Offices not later than noon on Thursday, the 8th February, 1906.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
F. A. LYALL,
Secretary.

COUNTY OF LONDON.—TO ENGINEERS AND OTHERS.

The London County Council invites TENDERS for the MANUFACTURE, SUPPLY, and ERECTION of THREE GAS ENGINES, each having three inverted single-acting cylinders over three cranks, and each capable of developing 350 brake horse-power at a speed of 100 revolutions per minute.

Persons desiring to submit Tenders may obtain the Drawing, Specification, Form of Tender, and other particulars upon application to the Chief Engineer, Mr. MAURICE FITZMAURICE, C.M.G., at the County Hall, Spring Gardens, S.W., upon payment to the Cashier of the Council of the sum of £2.

This amount will, after the Council or its Committee have come to a decision upon the Tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona fide* Tender, and not have withdrawn the same.

Tenders must be upon the official Forms, and the printed instructions contained therein must be strictly complied with.

The Contractors will be bound by the Contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in, and form part of the Contract by way of schedule.

Each Tender is to be delivered at the County Hall in a sealed cover addressed to "The Clerk of the London County Council, Spring Gardens, S.W.," and marked "Tender for Gas Engines Shad Thames Pumping Station."

No Tender will be received after 10 a.m. on Tuesday, February 20th 1906.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after the same had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the London County Council.

County Hall, Spring Gardens, S.W.
January 16th, 1906.

PAGE'S WEEKLY Contracts and Appointments Open

CITY OF CARDIFF.—The CARDIFF CORPORATION invite TENDERS for the SUPPLY of COOLING TOWERS, ELECTRICALLY-DRIVEN PUMPS, PIPE-WORK, &c., for their Roath Power Station.

General Conditions, Specifications, and Forms of Tender may be obtained from Mr. Arthur Ellis, City Electrical Engineer and Manager, Central Offices, The Hayes, Cardiff.

Sealed Tenders, endorsed "Cooling Towers," to be delivered at my office on or before Friday, February 16th.

J. L. WHEATLEY,
Town Clerk.

Town Hall, Cardiff, 17th January, 1906.

BRADFORD POOR LAW UNION.—The Guardians of the Bradford Poor Law Union are prepared to receive TENDERS from Masons and Bricklayers for the erection of PUMP-ROOM and STEAM-BOILER CHIMNEY, also TENDERS from Heating Engineers for the INSTALLATION of a SYSTEM of ATMOSPHERIC STEAM HEATING and MACHINERY in connection therewith, at the Union Hospital, Horton Lane, Bradford.

Contractors desirous of tendering for these Works are requested to forward their applications, along with a deposit of £2 2s. for each separate Contract (which will be returned on receipt of *bona fide* Tender), to Mr. Fred Holland, Engineer and Architect to the Board, 11, Parkinson's Chambers, Hustlergate, Bradford (Tel. No. 1,529), when particulars will be forwarded in due course. Drawings and Specifications may be seen at the Architect's Offices.

Sealed Tenders, on separate Forms of Tender supplied, to be endorsed "Pump-Room," "Chimney," "Atmospheric Heating," to be delivered to the undersigned not later than 9 a.m. on Monday, the 26th day February, 1906.

The lowest of any Tender will not necessarily be accepted, and the Tender of any person or firm who does not observe the fair contracts clauses referred to in specification will not be accepted.

By order,
GEORGE M. CROWTHER,
Clerk to the Guardians.

Union Offices, 22, Manor-row, Bradford,
January 18th, 1906.

EPSOM URBAN DISTRICT COUNCIL.

WATERWORKS PUMPING PLANT.

TENDERS are invited for SUPPLYING and ERECTING a GAS ENGINE and SUCTION GAS PLANT and a DEEP WELL PUMP capable of raising 50,000 gallons of water per hour against a head of 390 feet.

The work to be carried out to the specification, and to the satisfaction of Mr. W. VAUX GRAHAM, M.Inst.C.E., 5, Queen Anne's-gate, Westminster, from whom full particulars may be obtained on payment of £5 5s., which will be returned on receipt of a *bona fide* Tender.

Tenders must be sent in to Mr. E. G. WILSON, Clerk to the Epsom Urban District Council, Church Street, Epsom, marked "Tender for Pumping Plant," not later than first post on Monday, February 12th, 1906.

The Council do not bind themselves to accept the lowest or any Tender.

COUNTY BOROUGH OF SUNDERLAND.

ELECTRICITY DEPARTMENT.

TO MANUFACTURERS OF FEED PUMPS, COOLING TOWERS, AND SURFACE CONDENSERS.

The Corporation of Sunderland are prepared to receive TENDERS for the SUPPLY of—

(a) ONE BOILER FEED PUMP.
(b) ONE WOODEN COOLING TOWER.
(c) ONE SURFACE CONDENSER with Motor-Driven Pumps.
(d) COAL BUNKERS, GANTRY, and other Steelwork.

The Specifications and Forms of Tender can be obtained on application to the Borough Electrical Engineer, Mr. J. F. C. Snell, M.Inst.C.E., at his office, Town Hall, Sunderland, and on payment on £1 1s. (One Guinea) for each Specification, which will be returned on receipt of a *bona fide* Tender.

Sealed Tenders, addressed to the "Chairman of the Electricity and Lighting Committee," Town Hall, Sunderland, must be delivered at my office not later than 12 o'clock noon on Friday, the second day of March, 1906. Tenders to be endorsed "A, B, C, or D," according to item tendered for.

The Corporation do not bind themselves to accept the lowest or any Tender.

FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland, January, 22nd, 1906.

THE URBAN DISTRICT COUNCIL OF BARNES.

STEAM DYNAMO AND SWITCHBOARD PANELS.

The Urban District Council of Barnes are prepared to receive Tenders for the Supply, Delivery and Erection of a 300-kilowatt STEAM DYNAMO, together with SWITCHBOARD PANELS and CONNECTIONS.

Specification, General Conditions and Form of Tender can be obtained from the undersigned on payment of a deposit of £1 1s., which will be returned on receipt of a *bona fide* Tender.

Tenders to be sealed and endorsed "Steam Dynamo," and delivered to the Clerk, Council House, High-street, Mortlake, S.W., not later than FEBRUARY 12th, 1906.

The Council do not bind themselves to accept the lowest or any Tender.

C. S. DAVIDSON, Electrical Engineer.

Electricity Works, High-street, Mortlake, S.W.

APPOINTMENTS OPEN.

INDIAN PUBLIC WORKS DEPARTMENT.

The Secretary of State for India in Council will, in the Summer of 1906, make not less than TEN APPOINTMENTS of ASSISTANT ENGINEER in the Permanent Establishment of the Indian Public Works Department, in addition to the appointments to be made from Cooper's Hill College.

The age of Candidates must not be less than 21, or more than 24 years on the 1st July, 1906.

A printed Form of Application, together with information regarding the conditions of the appointments and certain requirements laid down as to education and experience in engineering, may be obtained from the Secretary, Public Department, India Office, Whitehall, London, S.W.

The Form of Application is to be returned so as to reach him not later than Tuesday, 1st May next.

A. GODLEY,
Under Secretary of State.

India Office, December 19th, 1905.

SINGAPORE, STRAITS SETTLEMENT.

MUNICIPAL ENGINEER'S DEPARTMENT.

The Municipal Commissioners of the Town of Singapore REQUIRE, as soon as possible, an ASSISTANT ENGINEER between 23 and 35 years of age, of sound constitution. He must have had a good technical education, a regular training as a Civil Engineer, experience in Surveys and Plans for and in the Construction of Reservoirs and Filters, and also in General Waterworks Construction, and he must be connected with the Institution of Civil Engineers.

The selected candidate must pass a medical examination.

The engagement will be for three years, and the applicant is to state the earliest date upon which he would be prepared to leave for Singapore.

Second-class passage will be provided by mail steamer, or first-class passage by other steamer, with half pay during voyage out.

Salary will be £360 for the first, £390 for the second, and £420 for the third year, paid monthly, with such local transport allowance as may, from time to time, be sanctioned by the Commissioners.

Applications, stating age and place of birth, and giving details of education, training, and experience generally, and in Waterworks and Municipal Engineering (if any), and referring to above requirements seriatim, accompanied by copies (only) of testimonials and personal references, to be lodged with C. C. LINDSEY, Esq., M.Inst.C.E., 180, Hope Street, Glasgow (who will give further particulars if requested), not later than Tuesday, 6th February, 1906.

ASSISTANT ENGINEER REQUIRED for the Colombo Drainage Works, Ceylon.

Candidates should be competent Surveyors, correct Levellers and Draughtsmen, and have had experience of Sewerage Construction.

Age between 27 and 32.

Salary Rs. 6,000 per annum, rising by annual increments of Rs. 300 to Rs. 6,900, with travelling allowance of Rs. 50 per mensem.

Engagement for four years, or sooner, on determination of work.

Free passage out and home again on satisfactory termination of engagement—second-class by mail steamer, or first by any other.

Strict medical examination.

Applications by letter (no special form required), stating age, whether married or single, full particulars of experience, and accompanied by copies of testimonials (not originals), with names and addresses of references of whom inquiry can be made as to qualifications and personal character, will be received by the Crown Agents for the Colonies, Whitehall Gardens, London, S.W., up to February 6th.

Any inquiries respecting the above appointment may be addressed to the Consulting Engineers, Messrs. JAMES MANSERGH & SONS, 5 Victoria Street, Westminster.

BUYERS' DIRECTORY.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 22 and 24.*

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

Advertisers' Service Bureau.
British Advertiser Service Bureau, Queen Anne's Chambers, Westminster, S.W.

Artesian Well Machinery.
John Z. Thom, Patricroft, Manchester.

Band Sawing Machines.
Noble & Lund, Ltd., Felling-on-Tyne.

Bearings (Roller).
Hyatt Roller Bearing Co., 47, Victoria Street, London S.W.

Belting.
Binney & Son, Catherine Street, City Road, London, E.C.
Cort, Arthur, & Co., Camberwell, London, S.E.
Fleming, Birkby & Goodall, Ltd., West Grove, Halifax.
Gilmour, W. & O., St. John's Hill, Edinburgh.

Boilers.
Clayton, Son & Co., Ltd., Leeds City Boiler Works, Leeds.
Hartley & Sugden, Ltd., Halifax.
Thompson, John, Wolverhampton.

Boilers (Water-tube).
Babcock & Wilcox, Ltd., Oriel House, Farringdon Street London, E.C.
Stirling Boiler Co., Ltd., Motherwell, N.B.

Bolts, Nuts, Rivets, etc.
Herbert W. Periam, Ltd., Floodgate Street Works, Birmingham.
T. D. Robinson & Co., Ltd., Derby.

Books.
Griffin, Charles, & Co., Exeter Street, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.
Spon, E. & F. N., 125, Strand, W.C.

Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.

Cables.
Callender's Cable and Construction Co., Ltd.

Case-Hardening Compounds.
Hy. Miller & Co., Millgarth Works, Leeds.

Castings.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.

Catalogues, Printing, &c.
Atlantic Press, Ltd., Weymouth Street, Manchester.
Spottiswoode Advertising Agency, Clun House, Surrey Street, Strand, W.C.
Stafford, Arthur, & Co., Denton, Manchester.

Chucks.
Fairbanks Co., 78-80, City Road, London, E.C.

Cisterns, Tanks, &c.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.
Clayton, Son & Co., Ltd., Hunslet, Leeds.
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Clutches (Friction).
David Bridge & Co., Castleton Ironworks, Rochdale, Lancashire.

Coke Oven Expert.
Mallmann, P. J., 110-118, Victoria Street, S.W.

Condensing Plant.
Benn, Sykes, Haslingden, near Manchester.
Concentric Condenser, Ltd., 23, Northumberland Avenue, London, W.C.
Mirrlees-Watson & Co., Ltd., Glasgow

Consulting Engineers.
Gibbs, John, & Son, 80, Juke Street, Liverpool.
G. H. Hughes, A.M.I.M.E., 19, Old Queen Street, Westminster, S.W.
Melville & Macalpine, 615, Walnut Street, Philadelphia, Pa., U.S.A.
Mount-Haes, A., M.I.Mech.E., M.I.M.E., 11, Ironmonger Lane, London, E.C.

Continental Railway Arrangements.
Northern Railway of France.
South Eastern & Chatham Railway Co.

Conveying and Elevating Machinery.
Adolf Bleichert & Co., Leipzig-Gohlis, Germany.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

Copper and Brass.
W. Hepton & Son, Hunslet Lane, Leeds

Coverings (Boiler).
Magnesia Covering Ltd., Washington Station, co. Durham.

Cranes, Travellers, Winches, etc.
Joseph Booth & Bros. Ltd., Rodley, Leeds.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Cranks.
Clarke's Crank & Forge Co., Ltd., Lincoln, England.

Cutters (Milling).
Pratt & Whitney Co., 23-25, Victoria Street, London, S.W.
E. G. Wrigley & Co., Ltd., Foundry Lane Works, Soho, Birmingham.

Destructors.
Heenan & Froude, 4, Chapel Walks, Manchester.
Horsfall Destructor Co., Ltd., Armley, Leeds.

Dredges and Excavators.
Delange & Cie, Mce., Hoboken, near Antwerp
Rose, Downs & Thompson, Ltd., Old Foundry, Hull.

Drilling Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne
Swift, George, Clarence Ironworks, Halifax.

Economisers.
E. Green & Son, Ltd., Manchester.

Ejectors (Pneumatic).
Hughes & Lancaster, 16, Victoria Street, London, S.W.

Electrical Apparatus.
Allgemeine Elektricitäts Gesellschaft, Berlin, Germany.
British Westinghouse Electric and Manufacturing Co., Ltd., Norfolk Street, Strand, London, W.C.
Broadbent, T. W., Victoria Electrical Works, Huddersfield.
Crypto Electrical Co., 3, Tyer's Gateway, Bermondsey Street, London, S.E.
Ebonestos Manufacturing Co., 22, Rosoman Street, London, E.C.
Gent & Co., Ltd., Faraday Works, Leicester.
Greenwood & Batley, Ltd., Albion Works, Leeds.
India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., Silvertown, London, E.
Johnson and Phillips, Ltd., Victoria Works, Old Charlton, Kent.
Matthews & Yates, Ltd., Swinton, Manchester.
Mix and Genest, Berlin, W., Germany.
Nalder Bros. & Thompson, 34, Queen Street, London, E.C.
New Gutta Percha Co., Ltd., Dashwood House, New Broad Street, E.C.
Newton Brothers, Full Street, Derby.
Phœnix Dynamo Manufacturing Co., Bradford, Yorks.
Scott, E., & Mountain, Ltd., Newcastle-on-Tyne.
Sturtevant Engineering Co., Ltd., 147, Queen Victoria Street London, E.C.
Turner, Atherton & Co., Ltd., Denton, Manchester.
B. Weaver & Co. (*see* Ebonestos Manufacturing Co.), 22, Rosoman Street, Clerkenwell, London, E.C.

Engineers' Supplies.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Engines (Gas).
Campbell Gas Engine Co., Ltd., Halifax.
Cundall, Son & Co., Ltd., Airedale Iron Works, Shipley.

Engines (Electric Lighting).
McLaren, J. and H., Midland Engine Works, Leeds.

Engines (Locomotive).
Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.
Hunslet Engine Co., Ltd., Leeds, England.
Hudswell Clarke & Co., Ltd., Leeds, England.
McLaren, J. & H., Midland Engine Works, Leeds.

Engines (Stationary).
Allis-Chalmers Co., 533, Salisbury House Finsbury Circus, London E.C.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Mirrlees Watson Co., Ltd., Glasgow.

Engines (Traction).
Jno. Fowler & Co. (Leeds), Ltd., Steam Plough Works, Leeds.

Engravers.
Jno. Swain & Son, Ltd., 58, Farringdon Street, London, E.C.

Exhaust Steam Oil Separators.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Fans, Blowers.
Capel Fan Co., 13, Moseley Street, Newcastle-on-Tyne.
Davidson & Co., Ltd., "Sirocco" Engineering Works, Belfast Ireland.
Gibbs, John & Son, 80, Juke Street, Liverpool.
Matthews & Yates, Ltd., Swinton, Manchester.

Files.
Flocktor, Tempkin & Co., Ltd., Newhall Steel Works, Sheffield.

Fire Bricks.
J. H. Sankey & Son, Ltd., Essex Wharf, Canning Town, London, E.

Firewood Machinery.
M. Glover & Co., Patentees and Saw Mill Engineers, Leeds.
Hill and Herbert, Ltd., Great Central Street, Leicester.

PAGE'S WEEKLY Miscellaneous

Buyers' Directory—(*Continued*).

Fountain Pens.
Mabie, Todd & Bard, 93, Cheapside, London E.C.

Forging (Drop) Plants.
Brett's Patent Lifter Co., Ltd., Coventry.

Forgings (Drop).
J. H. Williams & Co., Brooklyn, New York, U.S.A.

Furnaces.
Deighton's Patent Flue & Tube Company, Vulcan Works, Pepper Road, Leeds.
Leeds Forge Co., Ltd., Leeds.

Gauge Glasses.
J. B. Treasure & Co., Vauxhall Road, Liverpool.
Tomey, J., & Sons, Aston, Birmingham.

Gauges (Pressure, Vacuum, and Hydraulic).
Dobbie, McInnes, Ltd., 45, Bothwell Street, Glasgow.

Gearing.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.
Angus, G. & Co., Ltd., Newcastle-on-Tyne.
Asquith, William, Ltd., Well Road Works, Halifax.
Dixon, W. F., & Co., 60, Percival Street, C. on-M. Manchester
Reid Gear Co., Linwood, near Glasgow.
Wild, M. B., & Co., Corporation Street, Birmingham.

Gold Dredging Plant.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C

Greases.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London, S.E.

Hack Saws.
Baynes, Charles, Knuzden Brook, Blackburn.

Hammers (Steam).
Davis & Primrose, Leith Ironworks, Edinburgh.
Niles-Bement Pond Co., 23-25, Victoria Street, London, S.W.

Hoisting Machinery.
See Conveying Machinery.

Horizontal Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds.
Niles-Bement Pond Co., 23-25, Victoria Street London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Swift, George, Clarence Ironworks, Halifax.

Hydraulic Leather.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Hydraulic Machine Tools.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Vauxhall and West Hydraulic Engineering Co. Ltd., 23, College Hill, London, E.C.

Icemaking ana Refrigerating Machinery.
H. J. West & Co., 114-118, Southwark Bridge Road, London, S.E.

Indicators.
Dobbie McInnes, Ltd., 45, Bothwell Street, Glasgow.
Hannan & Buchanan, 75, Robertson Street, Glasgow.

Iron and Steel.
Allen, Edgar, & Co. Ltd., Imperial Steel Works, Sheffield.
Askham Bros. & Wilson, Ltd., Sheffield.
Buckley, Saml., St. Paul's Square, Birmingham.
Fairley & Sons, James, Old Mint, Shadwell Street, Birmingham.
Farnley Iron Co., Ltd., Leeds. England
Flockton, Tompkin & Co., Ltd., Newhall Steel Works, Sheffield.
Fried. Krupp, Grusonwerk, Magdeburg-Buckau, Germany.
J. Frederick Melling, 14, Park Row, Leeds, England.
Parker Foundry Co., Derby.
Purden, John & Sons, Lambhill Forge, by Maryhill, Glasgow.
Walter Scott, Ltd., Leeds Steel Works, Leeds, England.

Ironwork (Constructional).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Ironwork (Galvanised).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Lagging Sheets.
Zeitz & Co., 21, Lime Street, London, E.C.

Lathes.
Asquith, William, Ltd., Well Road Works, Halifax.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Eclipse Tool Manufacturing Co., Linwood, near Glasgow.
Leckenby, Benton, & Co., Perseverance Ironworks, Halifax.
Mitchell, D., & Co., Ltd., Parsonage Works, Keighley.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Northern Engineering Co. (1900), Ltd., King Cross, near Halifax.
Swift, George, Clarence Ironworks, Halifax.

Lathe Carriers
Williams, J. H., & Co., Brooklyn New York, U.S.A.

Laundry Machinery.
Hill and Herbert, Ltd., Great Central Street, Leicester.
Summerscales, W., & Sons, Ltd., Engineers, Phœnix Foundry Keighley, England.

Lifts.
Waygood & Co., Ltd., Falmouth Road, London, S.E.

Lubricants.
Blumann & Stern, Ltd., Plough Bridge, Deptford, London, S.E.
Reliance Lubricating Oil Co., The, 19 & 20, Water Lane, Great Towe Street, London, E.C.

Machine Tools.
Asquith, William, Ltd., Well Road Works, Halifax.
George Addy & Co., Waverley Works, Sheffield.
Bateman's Machine Tool Co., Hunslet, Leeds.
Beanland, Perkin, & Co., School Close Works, Leeds.
Bertrams, Ltd., St. Katherine's Works, Sciennes, Edinburgh.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Breuer, Schumacher & Co., Ltd., Kalk, near Cologne-on-Rhine (Germany).
Consolidated Pneumatic Tool Co., Ltd., Palace Chambers, 9, Bridge Street, Westminster, S.W.
Cunliffe & Croom, Ltd., Broughton Ironworks, Manchester.
Dean, Smith & Grace, Ltd., Keighley.
Dempster, Moore & Co., Ltd., 49, Robertson Street, Glasgow.
Fengl, A., & Co., Gratton Street, Altrincham.
Greenwood & Batley, Ltd., Leeds.
Jones & Lamson Machine Co., 97, Queen Victoria Street, London, E.C.
John Lang & Sons, Johnstone, near Glasgow.
Luke & Spencer, Ltd., Broadheath, Manchester.
Jos. C. Nicholson Tool Co., City Rd. Tool Wks., Newcastle-on-Tyne.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Northern Engineering Co., 1900, Ltd., King Cross, near Halifax.
J. Parkinson & Son, Canal Ironworks, Shipley, Yorkshire.
C. Redman & Sons, Halifax.
Resides, 12, Aire Street, Brighouse, Yorks.
Rice & Co. (Leeds), Ltd., Leeds, England.
G. F. Smith, Ltd., South Parade, Halifax.
Swift, George, Clarence Ironworks, Halifax.
Taylor and Challen, Ltd., Derwent Foundry, Constitution Hill Birmingham.
Vauxhall and West Hydraulic Engineering Co., Ltd., 23, College Hill, London, E.C.
H. W. Ward & Co., Lionel Street, Birmingham.
T. W. Ward, Albion Works, Sheffield.
West Hydraulic Engineering Co. (see Vauxhall and West Hydraulic Engineering Co. Ltd.), 23, College Hill, London, E.C.
Winn, Charles, & Co., St. Thomas Works, Birmingham.
Yorkshire Machine Tool and Engineering Works, Liversedge, Yorks.

Machinery Merchants.
Greenwood, Thomas, Waterside, Halifax.

Marks.
Pryor, Edward, & Son, 68, West Street, Sheffield.

Metals.
Delta Metal Co., Ltd., East Greenwich, London, S.E.
Magnolia Anti-Friction Metal Co., Ltd., of Great Britain, 49, Queen Victoria Street, London. E.C.
Phosphor Bronze Co., Ltd., Southwark, London, S.E.

Metals (Perforated).
Brown, Andrew, & Co., 110, Cannon Street, London, E.C.
Méguin, Fr., & Co., Ltd., Engineering Works, Dillingen-on-Saar.

Mining Drill Steel.
Flockton, Tompkin & Co., Ltd., Newhall Steel Works, Sheffield.

Mining Machinery.
Fraser & Chalmers, Ltd., 3 London Wall Buildings, London, E.C.

Office Appliances.
Davis John, & Son, Ltd., 30, All Saints' Works, Derby.
Halden & Co., J., 8, Albert Square, Manchester.
Hall & Co., B. J., 39, Victoria Street, London, S.W.
Inglesant, T., & Sons, Ltd., Atlas House, Leicester.
Lyle Co., Ltd., Harrison Street, Gray's Inn Road, London, W.C.
Rockwell-Wabash Co. Ltd., 69, Milton Street, London, E.C.
Shannon, Ltd., Ropemaker Street, London, E.C.
Trading and Manufacturing Co., Ltd., Temple Bar House, Fleet Street, London, E.C.

Oils, &c.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London, S.E.

Oil Filters and Cabinets.
Valor Co., Ltd., Rocky Lane, Aston Cross, Birmingham.

Packing.
Beldam Packing & Rubber Co., 93-94, Gracechurch Street, London E.C.
Lancaster & Tonge, Ltd., Pendleton, Manchester.
Redfern & Co., S., Swan Lane, New Brown Street, Manchester
Quaker City Rubber Co., Coronation House, Lloyd's Avenue, E.C.
United States Metallic Packing Co., Ltd., Bradford.

Paper.
Lepard & Smiths, Ltd., 29, King Street, Covent Garden, London, W.C.

Patent Agent.
Lorrain, J. G., M.I.E.E., M.I.Mech.E., Norfolk House, Norfolk Street Strand, London, W.C.

PAGE'S WEEKLY Miscellaneous

Buyers' Directory—(*Continued*).

Photo Copying Frames.
J. Halden & Co., 8, Albert Square, Manchester.
B. J. Hall & Co., 39, Victoria Street, London, S.W.

Photographic Apparatus.
Marion & Co., Ltd., 22 and 23, Soho Square London, W.

Pinch Bars.
Samson & Co., Garforth, near Leeds.

Pipe Wrenches (Chain).
Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Pistons.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Planished Sheets.
Zeitz & Co., 21, Lime Street, London, E.C.

Pneumatic Tools.
Consolidated Pneumatic Tool Co., Ltd., Palace Chambers, 9, Bridge Street, Westminster, S.W.

Porcelain.
Gustav Richter, Charlottenburg, near Berlin, Germany.

Presses (Hydraulic).
Greenwood & Batley, Albion Works, Leeds
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Publishers.
Charles Griffin & Co., Ltd., Exeter Street, Strand, London, W.C.
Spon, E. and F. N., 125, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.

Pulley Blocks.
Kramos Ltd., Locksbrook Engineering Works, Bath

Pumps and Pumping Machinery.
Drum Engineering Co., 33, Brook Street, Bradford
Enke, Carl, Schkeuditz Leipzig, Germany.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
J. P. Hall & Sons, Ltd., Peterborough
Hathorn, Davey & Co., Ltd., Leeds, England.
Positive Rotary Pumps, Ltd., 23, Northumberland Avenue, London, W.C.

Radial Drilling Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds
Mitchell, D., & Co. Ltd., Parsonage Works, Keighley.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne
Northern Engineering Co. (1900), Ltd., King Cross, near Halifax.
Swift, George, Clarence Ironworks, Halifax.

Rails.
Wm. Firth, Ltd., Leeds

Riveted Work.
F. A. Keep, Juxon & Co., Forward Works, Barn Street, Birmingham.

Roller Bearings.
Hyatt Roller Bearing Co., 47, Victoria Street, London, S.W.

Roofs.
D. Anderson & Son, Ltd., Lagan Felt Works, Belfast.
Clayton, Son & Co., Ltd., Hunslet, Leeds
Head, Wrightson & Co., Ltd., Thornaby-on-Tees.
McTear & Co., Ltd., Newtownards Road, Belfast.

Ropeways (Aerial).
Bullivant & Co., Ltd., 72, Mark Lane, London, E.C.
Pohlig, J., Ltd., Cologne, Germany.

Scientific Instruments.
Cambridge Scientific Instrument Co., Ltd., Cambridge

Slotting Machines.
Swift, George, Clarence Ironworks, Halifax.

Spanners.
Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Stampings.
Thomas Smith & Sons of Saltley, Ltd., Birmingham.
Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Stamps (Rubber).
Rubber Stamp Co., 1 & 2, Holborn Buildings, Broad Street Corner, Birmingham.

Stamps (Metal).
Edward Pryor & Son, 68, West Street, Sheffield.

Steam Traps.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Steam Wagons.
Thornycroft & Co., Ltd., J. I., Chiswick, London, W.
Yorkshire Patent Steam Wagon Co., Pepper Road, Hunslet, Leeds

Steel Structures.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.
Clayton, Son & Co., Ltd., Hunslet, Leeds.

Steel Tools.
Saml. Buckley, St. Paul's Square, Birmingham.
Pratt & Whitney Co., 23-25, Victoria Street, London, S.W.

Steel (Tool Steel).
Flockton, Tompkin & Co., Ltd, Newhall Steel Works, Sheffield.

Stokers.
Ed. Bennis & Co., Ltd., Bolton, Lancs.

Stone Breakers.
S. Pegg & Son, Alexander Street, Leicester.

Superheaters.
A. Bolton & Co., 40, Deansgate, Manchester.

Testing Machines.
Denison, Saml., & Son, Ltd., Hunslet Moor, near Leeds.

Time Recorders.
Howard Bros., 40, Paradise Street, Liverpool, and 100b, Queen Victoria Street, London, E.C.

Tubes.
Thomas Piggott & Co., Ltd., Spring Hill, Birmingham.
Tubes, Ltd., Birmingham.

Turbines.
Greenwood & Batley, Albion Works, Leeds.
S. Howes Co., 64, Mark Lane, London, E.C.

Typewriters.
Empire Typewriter Co., 77, Queen Victoria Street, London, E.C.
Yost Typewriter Co., 50, Holborn Viaduct, London, E.C.

Valves.
Holmes & Co., W. C., Huddersfield.
Hopkinson, J., & Co., Ltd., Britannia Works, Huddersfield.
Hunt & Mitton, Crown Brass Works, Oozells Street North Birmingham
Scotch and Irish Oxygen Co., Ltd., Rosehill Works, Glasgow
Shaw, Joseph, Albert Works, Huddersfield.
Winn, Charles, & Co., St. Thomas Works, Birmingham.

Ventilating Appliances.
Matthews & Yates, Ltd., Swinton, Manchester

Water Softeners and Purifiers.
Lassen & Hjort, 52, Queen Victoria Street, London, E.C.

Wagons—Steam.
Thornycroft & Co., J. I., Ltd., Chiswick, London, W.
Yorkshire Patent Steam Wagon Co., Pepper Road, Hunslet, Leeds.

Weighing Apparatus.
W. & T. Avery, Ltd., Soho Foundry, Birmingham, England.
Denison, Saml., & Son, Ltd., Hunslet Moor, near Leeds.

Wells Light.
A. C. Wells & Co., 100A, Midland Road, St. Pancras, London, N.W.

Wire Ropes.
Bullivant & Co., Ltd., 72, Mark Lane, London, E.C.

Wire Working Machinery.
Ed. Brand, 35, Shakespeare Street, Manchester.

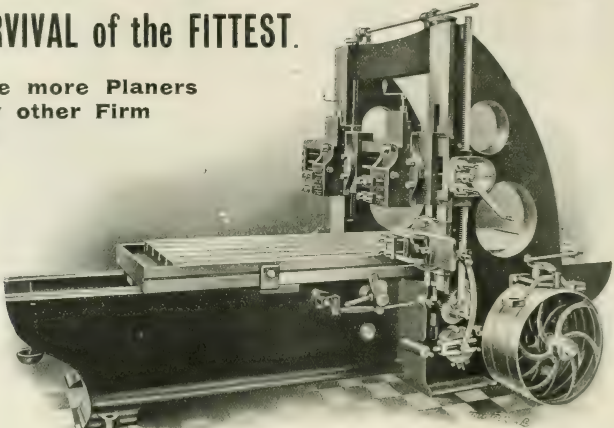
"Woodite."
"Woodite" Company, Mitcham, Surrey

PAGE'S WEEKLY — Machine Tools

PAGE'S WEEKLY Machine Tools

The SURVIVAL of the FITTEST.

We make more Planers than any other Firm in Great Britain.



Ask specially for Planing Machine Catalogue.

C. REDMAN & SONS, Pioneer Ironworks, HALIFAX.

CUNLIFFE & CROOM, Ltd.

MACHINE TOOL MAKERS,

Broughton Lane, MANCHESTER.

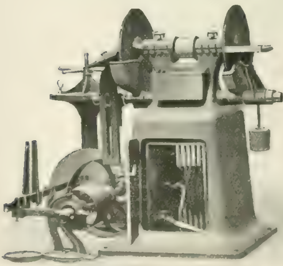


Illustration shows 18-in. Disc. Grinder. May be seen at work at our Showroom, VICTORIA STREET, MANCHESTER.

DISC GRINDERS.

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PAGE'S WEEKLY Machine Tools, &c.

PAGE'S WEEKLY Miscellaneous

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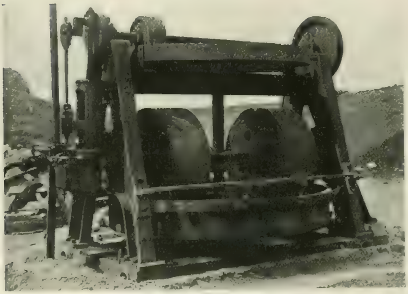

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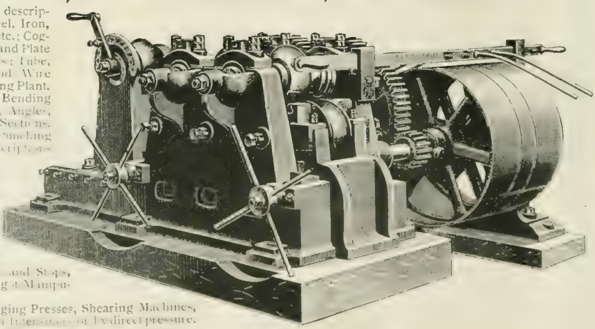

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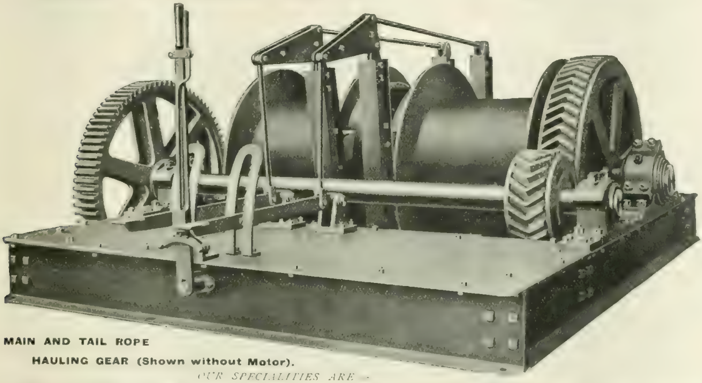

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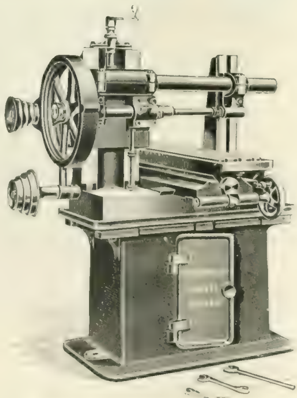

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PAGE'S WEEKLY Time Recorders

PAGE'S WEEKLY — Steelwork, &c.

Index to Advertisers.

Advertisements not appearing this week will be found by reference to the preceding or following issues, with the exception of those appearing monthly.

Index to Advertisers—(Contd.)

PAGE'S WEEKLY Miscellaneous

PAGE'S WEEKLY Miscellaneous

PAGE'S WEEKLY

An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

Vol. VIII. LONDON, FRIDAY, FEBRUARY 2, 1906 No. 73.

The Offices of "Page's Weekly," Wednesday Evening.

WITH the formal opening of the Nile—Red Sea Railway, commences the serious development of the Soudan. By the aid of the engineer, the distance from Berber to the Sea has been shortened by about 900 miles at a single coup and the way has been paved for the further improvements which are ultimately to render the Soudan self-supporting. Although these improvements have been already foreshadowed in these columns it will be interesting to review them in the words of Lord Cromer on Saturday :—" The new railway is the first and preliminary step in the gradual execution of a large scheme for the construction of works of public utility. It is the main artery of communication which will open out the Soudan to the world. But before the country can gain the full advantages to be derived from this undertaking further works must be constructed. Some, indeed, have been already commenced. Port Soudan is springing into existence. Before many months have elapsed it is hoped that the railway from Kareima to Abu Hamed will be opened, and the wealthy province of Dongola thus put in direct communication with the sea. Irrigation works are about to be undertaken to utilise the waters of the Gash, and thus fertilise the plains in the neighbourhood of Kassala. Borings are about to be made with a view to the construction of a bridge over both the Blue and White Niles at Khartoum. Railway surveys are being undertaken with the ultimate object of bringing Kassala into communication with the main line, of extending the railway up the left bank of the Blue Nile, and of enabling the gum of Kordofan to find a ready market by bringing El Obeid into direct communication

Photo, [illegible]

EARL CROMER, [illegible], G.C.B., G.C.M.G.,

Agent and Consul-General in Egypt since 1883, who [illegible] the Nile–Red Sea Railway.

Photo, Booker and Sullivan.

THE ALDWYCH-HOLBORN SUBWAY.

View from the incline at Theobald's Road entrance.

with Omdurman." It is not suggested that all these works will be at once remunerative, but that they will ultimately prove remunerative Lord Cromer is extremely sanguine.

Details of the construction of the railway were furnished in brief by Col. Macaulay, R.E., Director of the Soudan Government Railways. It has over 300 miles of main line and 25 miles of sidings. The cost of constructing the line was £E.1,375,000, which works out at £E.4,150 per mile of main line. Work on the main line at Suakin began in August, 1904, and railway communication between the Nile and the Red Sea was opened in October, 1905. Owing to the insufficiency of the local water supply, it was necessary to obtain all water for working parties, and most of the water for bridges, buildings and locomotives, by distilling sea water. All water had to be carried up the line in special tank wagons. He acknowledged the valuable advice he had received from Mr. Bakewell, C.E., regarding the general course and construction of the line, and especially in the matter of bridging, and expressed his thanks to his staff. The construction of 325 miles of railway in fourteen months under the trying climate of the Soudan was characterised by Lord Cromer as "a very remarkable achievement."

The accompanying illustration of the Boston Subways, reproduced by special permission from Mr. Fell's recent report, is of interest in view of the completion of the Aldwych-Holborn Subway, and its opening for traffic in the course of the next few weeks. According to Mr. Fell, the conditions of traffic in the Boston subways are typical of those which may be expected in London. It is worth noting that the single-deck bogie cars now being completed for the Aldwych subway are the first steel vehicles for tramway service to be built in this country. The extensive use of aluminium in the internal fittings is another interesting feature. As the new route will connect up the Strand with Islington, a heavy traffic is doubtless to be anticipated, but here, at any rate, there will be no "strap hanging," and visitors coming to the surface from the Temple Station of the Underground and boarding an Aldwych tram will, we imagine, experience an agreeable change.

The fact that a train carrying a party of engineers and their friends passed through the Simplon tunnel on the 25th ult. seems to have given rise to some misconceptions regarding the time at which the tunnel will be available for regular traffic. There is yet much to be done. A *Times* correspondent writes:—"A most minute inspection of each arch in the roof of the tunnel is now being carried out. There will also be a daily examination of the ceiling and of the sidewalls by means of a car carrying a benzine motor, which works a dynamo, two fixed arc lamps and one arc lamp to which a powerful reflector is attached. This lamp

can be moved in any direction, and it will flood with a luminosity equal to daylight every nook and cranny, so that any defects which may exist can be easily detected and immediately repaired. Each of the cables will contain five wires belonging to the Federal Post and Telegraph Service and to the railways. The signalling will be done by means of the Bloch Lumier telephone apparatus (lamp signalling). A sixth wire destined solely to serve military purposes, is to be laid by the staff of the Swiss Federal Railways from the frontier to the centre of the tunnel. At Brigue railway station there are already waiting wagons loaded with 110 coils of cable, each from 350 to 600 metres long. As soon as this work is finished, Messrs. Brown, Boveri, and Co., of Baden, Switzerland, will lay the cable for the system of electric traction between the stations of Brigue and Iselle, for which work they are the contracters but whatever may happen, traffic will be begun on June 1st next. If the electric installation is not ready, or if it does not work smoothly by then, steam traction will be resorted to."

IN the discussion which followed Professor Ripper's paper (dealt with on page 252) at the annual meeting of the Association of Technical Institutions, concerning the co-operation of employes in the technical training of apprentices, Mr. Alexander Siemens objected to employers being treated as if they did not know their own interests. He was in favour of the student having his

BOSTON SUBWAY INCLINE.

technical training before he entered the works, and for a proper training he recommended the young man to devote himself to day training. Mr. E. G. Ogilvie (chief of the technological branch of the Board of Education) said the subject was one in which the Board of Education had taken a great interest, and they were endeavouring to spread that interest as widely as possible in the country. The result of the inquiry which the association had carried out was such as to show that there was already in the working of the technical institutions a sufficient body of men of experience to lead the way and show the method for improvement in the direction that they all had at heart.

The new president of the Association, Sir William Anson, M.P., evidently views the attitude of employers in a most favourable light, for he remarked in his presidential address that "the encouragement given by employers to technical study would be far reaching in its results, and would affect for good the preparatory work done in secondary and elementary schools." He added that there was another aspect of the connection of the work of the Association with industries. He hoped that it might serve to encourage a movement which was beginning and which he might express in words taken from the presidential address of Sir John Wolfe Barry:—"We want to see in Great Britain a man of science installed in his laboratory in all important manufactories and encouraged to help in their development."

The sixth International Congress of Applied Chemistry, to be held in Rome in 1906 under the patronage of the King of Italy, will begin with a social meeting of the members in the evening of April 25th. The following morning the official opening meeting will be held; and in the afternoon of the same day the first general meeting for the election of the Presidential Committee. On the 27th, sectional meetings will commence and will continue on the 28th and 30th of April and 1st and 2nd of May. During the Congress lectures on general subjects will be delivered. Professors Henri Moissan, William Ramsay and Otto N. Witt have already promised to lecture. On Sunday, 29th April, an excursion will be made in the neighbourhood of Rome. The concluding meeting of the Congress will be held on May 3rd.

The State Railways of Italy will grant a reduction of 40 to 60 per cent. to members of the Congress on the prices of ordinary railway tickets according to the extent of the journey, and the navigation companies "Navigazione Generale Italiana" and "La Veloce" will allow them a reduction of 60 per cent. on the value of tickets for any journey on their lines. A programme of the entertainments and festivals, to which members and their lady friends will be invited, is in course of preparation. Members will also have the option of joining one of the two excursions that will take place after the close of the Congress. A trip will be taken to the island of Sicily with the object of visiting a sulphur mine, the salt works of Trapani and the wine factories of Marsala. The other excursion will be made to the island of Elba and the boric "Soffioni" of Tuscany. Further details of the Congress, membership, etc., can be obtained from the office at 89, *via* Panisperna, Rome. All persons interested in the advancement of applied chemistry are eligible for membership.

We understand that a very advantageous level site on the Wash, known as Freiston Shore, has been acquired by the amalgamated firms of the Coventry Ordnance Company and Messrs. Cammell, Laird and Co., of Birkenhead and Liverpool, for use as a range on which to test guns and armour-plate. Plans have already been submitted to the Board of Trade.

PAGE'S WEEKLY

An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

DAVIDGE PAGE, Editor.

Clun House, Surrey Street, Strand, London, W.C.
Telephone No. [illegible] 49 GERRARD
Telegraphic and Cable Address: "SINEWY, LONDON."

Editorial.—*All communications intended for publication [illegible] "The Editor."*

Any contributions offered, as likely to interest [illegible] readers, dealing with the industries covered [illegible] and addressed envelope for the return of the MSS if [illegible] d, and the full name and address of the [illegible] MSS.

The [illegible] Page's Weekly [illegible] the contrary.

Correspondence *is invited from any person upon subjects of interest to the engineering community. In all cases this must be accompanied by full name and address of the writer, not necessarily for publication [illegible] be taken of anonymous communications.*

The Editor does not hold himself responsible for th[illegible] [illegible]rily identify himself with the[illegible].

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New Copy for Advertisements,

Alterations [illegible] for insertion in the current week's issue must be delivered **not later than 4 p.m. on Monday.** If proofs are required the copy and blocks should reach us [illegible] days earlier.

Personal Pars.

The Prince of Wales [illegible] the foundation [illegible] Institute [illegible].

Alderman [illegible] Jenkins, [illegible] Labour member for Chatham, has had [illegible] connection with the shipbuilding industry. In [illegible] he presided at the Trade Union Congress [illegible] Cardiff and was Mayor of Cardiff in [illegible].

Lord Inverclyde, presiding at the annual meeting of the Glasgow Shipowners' Association, announced that satisfactory negotiations were proceeding between the Board of Trade and Lloyd's Register with regard to the revision of free board rules.

Professor W. W. Watts, M.A., F.R.S., of Birmingham University has been appointed to the Professorship of Geology at the Royal College of Science, South Kensington, vacant by the retirement of Professor Judd.

Mr. W. Ridley Makepeace advises us that he has resigned his position as secretary of Messrs. Head, Wrightson and Co., Ltd., and accepted the appointment of general commercial manager of Messrs. John [illegible] and Co., Ltd., Gateshead-on-Tyne, from the 1st of February.

Mr. W. Bradford, whose paper on the use of th[illegible] [illegible] dealt with in the present issue, [illegible] an enthusiast on the question of reduced mining costs. The [illegible] is increasing its milling equipment by an additional [illegible] stamps and three tube mills, and to cope with this new crushing equipment [illegible] the mine with [illegible].

CONTENTS.

Birmingham Electric Supply.

A Local Government Board inquiry was held in Birmingham on Tuesday, into an application by the Birmingham Corporation for power to borrow £132,000 for the purpose of their electric supply undertaking. It was explained that the main reason for additional expenditure was the development of the tramways system. In 1903 the corporation took over about 33 miles of line. Since then additional powers had been obtained, and in the course of the next 18 months there would be about 64 miles of tramways within the city. The whole of those lines, with the exception of seven miles, the leases of which would not expire until 1911, would have to be worked by the corporation in about 18 months. The additional sums for which power was asked to borrow were for the purpose of laying down plant to meet the tramway requirements and for a further station at Saltley.

Motor Hiring Scheme.

The Electric Supply Committee of the Birmingham Corporation have for some time past had under consideration the adoption of a motor-hiring scheme, the object being to benefit small manufacturers, and at the same time to build up a profitable dayload power output. They now recommend that they be authorised to supply motors and starting switches on the hire system, on terms of rental proportionate to the horsepower of the motor. In case a consumer should desire to purchase a motor that has been hired to him the Committee propose to give him facilities for doing so. It is estimated that a sum of £8,000 to £10,000 will be required for the working of the scheme for about the first two years. The Committee intend to oppose the Shropshire, Worcestershire, and Staffordshire Electric Power Bill, 1906, with the view to obtaining the exclusion of Birmingham from the proposed area of supply.

The New Roof at Charing Cross.

Before the Manchester University Engineering Society on Wednesday night Mr. W. Noble Twelvetrees delivered a lecture on the "Safety of Iron and Steel Roofs" in view of the Charing Cross disaster. Mr. Twelvetrees said that one lesson from the accident was that welded tie bars, made in the days of wrought iron and still remaining in large roof structures should be supplemented especially if not in duplicate by auxiliary tension members.

With regard to the new roof the company had decided to substitute a roof of modern type at a lower level. The new roof was designed on the ridge-and-furrow system, the ridges running at right angles across the station. The principals would be carried by latticed girders extending from side to side of the station, and these girders would be supported by the side walls and by two lines of columns placed in the middle of the platforms. The total height of the roof would not be more than 3[illegible] ft. to 4[illegible] ft. above rail level, which would give increased facilities for maintenance.

Armstrong College

The Council of the Armstrong College, Newcastle-on-Tyne, has resolved to establish a chair of electrical engineering, and a sum of £2,600 has been voted towards the equipment of new laboratories. The appointment of chief will, of course, be thrown open for competition, although there is a strong feeling in favour of Prof. W. M. Thornton, who has been in charge of the electrical engineering section of the college for several years past. The Council have also decided to offer for competition two scholarships, each worth £125 annually, to be held by graduates of the college on the condition that they spend their time in the prosecution of definite research.

Canal Haulage.

Messrs. J. I. Thornycroft and Co.'s barge *[illegible]*, which is making a 1,000 mile tour of the canals for the purpose of demonstrating the economy of the Thornycroft marine suction gas-engine has entered upon its return journey from Manchester to Brentford, and at the time of writing has reached Middlewich. Although no figures relating to the test are yet available the tour is understood to have been a great success. Demonstrations have been given to barge owners and engieers in Birmingham and Manchester. The gas for the internal combustion engine is made and cleansed automatically, as it is required, from coke or coal. The barge carries a load of eleven tons and has acted as a tug to six other loaded barges.

Another effort is to be made next session to secure the approval of Parliament to the construction of a barrage or dam across the Thames between [illegible] and Gravesend. The promoters of the Bill propose the formation of a Board of Commissioners which would give a preponderance of representation to the representatives of statutory authorities.

A New Forced Draught Smoke-Consuming Furnace.

The Horsfall Company's engineers have lately designed a new "Sectional" Forced Draught furnace which is illustrated by the annexed photographs taken

from a scale model of the furnace, as applied to Lancashire Boilers. It combines the points of the closed ashpit with those of the hollow bar. The grate, consisting either of fine spaced bars, or of plates with conical holes (according to the nature of fuel, etc.), forms the top of a trough which is divided into several sections by longitudinal diaphragms, and each section is provided with a separate steam jet of the "Lords" patent type, thus forming a complete steam boiler, the bottom of the trough being curved to a trumpet shape so as to ensure a high degree of efficiency.

The air blown in is thus confined strictly to that part of the grate through which it ought to be blown, and if a hole is formed through slack or careless firing its effects are confined to one section, the other sections maintaining their full efficiency. The spaces in the grate being very fine, only a very small quantity of ash passes through. This is readily removed from the trough by means of a special rake.

The steam is not permitted to come in contact with the boiler plates, and the ashes are also prevented from lying on the plates, so that a frequent source of corrosion of flue tubes is avoided.

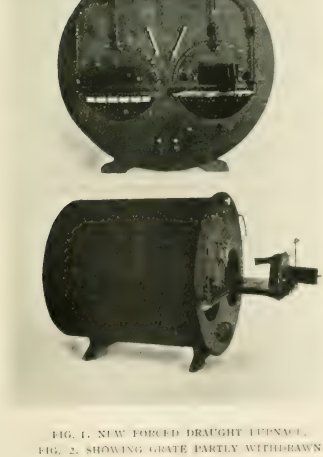


FIG. 1. NEW FORCED DRAUGHT FURNACE.
FIG. 2. SHOWING GRATE PARTLY WITHDRAWN.

The smoke [illegible] the same as in the "Lords" patent furnace. It consists of a separate blower or air injector over the grate, which draws its air supply through the hollow [illegible] behind the firing front, the air being thus heated and the plate at the same time kept cool. A supply of hot air easily regulated as to quantity is thus delivered into the heart of the gases rising from the fire which are thoroughly stirred and mixed therewith, so that reasonable care on the part of the stoker is only needed to secure perfect smoke prevention. It is claimed that with this furnace [illegible] to [illegible] lbs. of fuel per square foot of grate per hour can be easily burnt, with a corresponding increase in the output and efficiency of the boiler. It is applicable to every class of boiler and is specially suitable for burning small and dirty coals, coke breeze, anthracite duff, and such fuels as are difficult to keep steam with in ordinary furnaces.

In the illustrations fig. 1 represents the furnace as in actual operation. Fig. 2 shows the grate partly withdrawn from the boiler in order to exhibit the details of the grate and of the smoke consuming arrangements. It should be noted that the steam pipe to blowers is provided with a pressure gauge and stop valve in order that the steam may be [illegible] to a suitable pressure for the highest efficiency.

Correspondence.

THE FUTURE OF OUR CANALS.

To the Editor of PAGE'S WEEKLY.

SIR,—In connection with the remarks in your issue of the [illegible] on the [illegible] subject, it may perhaps be of interest to your readers to know that the system of electric [illegible] by Mr. Leon Gerard and Mr. [illegible] in the paper recently read before the International Congress of Navigation at Milan and referred to in PAGE'S WEEKLY was fully explained by Mr. [illegible] Martin, the well-known American [illegible] and an authority on canal haulage systems, in the Electrical World and Engineer of November [illegible]. The method [illegible] of the [illegible] system of [illegible] holds the right of the [illegible].

Yours faithfully,

A. [illegible]

[illegible] Company, L[illegible]

Technical Society Notes.

THERE was quite a candid friend type of discussion on Mr. Carter's paper on technical problems in connection with electrical railway engineering at the Institution of Electrical Engineers last week. Mr. Philip Dawson, who is the consulting engineer in connection with the electrification of the London, Brighton and South Coast Co.'s suburban lines, played the part of the candid friend, and made a speech in which the conclusions of the author were assailed and controverted at every turn. The paper itself is printed in the current issue, and it will be noted as a general dictum that the author looks upon continuous current working as the best for dealing with suburban traffic. Mr. Dawson absolutely disagrees with this conclusion, and challenges the author's figures in no half hearted way. Let us give chapter and verse. Mr. Carter states that the amount to be added for revolving masses reaches [illegible] per cent. in the case of continuous motors, and double that in the case of single-phase motors, whereas Mr. Dawson is of opinion that not more than 13 per cent. has to be added in the case of the latter.

This critic also joins issue with the author in regard to the amount dissipated in rheostatic losses, stated to be as great in single-phase machine as in continuous current machinery owing to the alleged lower efficiency of the former. Mr. Dawson quoted in support of his contention the figures of an actual test. He states that in a run of [illegible] feet on the level for two trains, one equipped with eight 150 h.p. D.C. motors and one with eight 115 h.p. W.E. alternating current motors, the single-phase train made the run in [illegible] seconds, and the D.C. train in [illegible] seconds. The average efficiency in the case of alternating current was 74.2 per cent. as against [illegible] per cent. with continuous current, and the watt hours per ton mile were [illegible] watt hours for A.C. as against [illegible] watt hours in the case of continuous current. As regards acceleration the single-phase train reached [illegible] miles per hour in [illegible] seconds, whereas the continuous current train only reached [illegible] miles per hour in [illegible] seconds.

With regard to curves given in Mr. Carter's paper, [illegible] drawn as to the uniformity [illegible] that the data on [illegible] Mr. Carter [illegible] are incorrect. Mr. Dawson [illegible] to have plotted a curve from [illegible] practically identical with that given by the author for continuous current motors. He also emphasises the fact that additional capital expenditure is required in continuous current working, and expresses the belief that the total efficiency of such a system is nearer 74 or 75 per cent., than the 78 per cent. claimed for it by the author of the paper. Finally, it is asserted that the days when it could be said that no practical single-phase motor could possibly be designed are over, and this caustic critic sums up the advantages of single-phase current for railway working as smaller capital cost, lower working expenses, less danger of electrolysis, and more favourable acceleration. He adds, in a final burst of unrelieved candour, that the only system of electric traction which satisfactorily solves the problem of handling suburban traffic on main line railways, is the single-phase alternating current which the Brighton Company has decided to adopt, a conclusion which is the exact opposite to that set forth in Mr. Carter's Paper.

Professor J. D. Cormack selected the subject of boiler trials for the honorary member's lecture to the Junior Institution of Engineers last Friday, and although we are unable to do more than briefly refer to the leading points of the lecture, those interested in the subject would do well to study same in full when it appears in the Transactions of the Institution. The efficiency of a boiler may of course be stated in various ways. It may be merely a statement of the number of pounds of water evaporated per pound of coal consumed; or it may be stated as the ratio of the whole heat obtained in the steam to the heat in the fuel used. The efficiency as defined by the number of pounds of water evaporated per pound of coal consumed, is not a suitable basis on which to compare different boilers, unless statements are made regarding the calorific value of the fuel, and the number of heat units contained in one pound of the steam.

The results of many boiler trials which have been published contain a statement of the performance only in terms of the water evaporated per pound of fuel without giving any indication either of feed temperature, boiler pressure or nature of fuel used. Such results are very misleading, and should not be regarded as either reliable or useful. In a complete trial the whole heat supplied to the boiler by the

combustion of the fuel ought to be accounted for, and statements should be made showing the magnitude and extent of the various losses.

It was pointed out by Prof. Cormack that engineers and manufacturers are often very careful to indicate their engines, but it is obvious that an indicator diagram, while it records many deficiencies in the working, tells nothing regarding many points which make for economy. To ascertain if there is any departure from the normal working it is only necessary as stated above to note the water evaporated and the coal consumed, but if it is desired to locate the loss, a knowledge of the analysis of the coal and temperature and the analysis of the flue gases is also required. Prof. Cormack deals especially with this subject, and he points out the correct way in which a boiler trial should be made, paying particular attention to the tendency to omit consideration of one or two factors which make an otherwise elaborate trial, devoid of real value. Prof. Cormack did more than lecture to the Junior Engineers on boiler trials, as he invited them on the day following his lecture to pay a visit to University College, where the method of conducting a boiler trial was demonstrated by himself and his assistants.

We are glad to be able to congratulate the Junior Institution of Engineers upon a marked advance. In future the transactions are to be issued in monthly parts, and the Publications Committee, with the object of making the journal of direct interest to members in their everyday work, intend to devote space each month to queries and notes that may be submitted. Questions of engineering interest are invited. This arrangement will give members an opportunity for mutual assistance, which the committee hope will be taken advantage of. The columns of the journal will also be open to correspondence on matters affecting the welfare of the Institution and for the discussion of engineering subjects in general. The part before us shows that the idea, attributed, by the way, to Mr. [illegible] H. [illegible] is already working well. It includes Mr. Dugald Clerk's essay on the "Gas Turbine," and several professional papers by Mr. W. J. [illegible]. We hear nothing about a new set of rules, but, doubtless, in accordance with well established precedent, the [illegible].

Dr. [illegible] F.R.S., presented a paper to the last meeting of the Physical Society by Dr. Thomas R. Lyle and Mr. J. N. [illegible], dealing with experiments on the propagation of longitudinal waves of magnetic flux along iron wires and rods. Dr. [illegible] said that the experiments were undertaken with the object of determining if there was a definite rate of propagation of magnetism in iron. The method adopted was to produce magnetisation by means of a coil through which an alternate current was passed at a particular point on the bar, and then to observe the magnetic flux at various distances from that coil by means of a small secondary exploring coil, free to be moved to various places on the bar. By the use of Prof. Lyle's wave-tracer the form of wave of magnetic flux at various points along the bars was then obtained. The wave curve was next analysed into a Fourier's series. Various curves given in the paper show the values of the constants in this Fourier's series and of the lag in the magnetisation at various points as the coil was moved along the bar.

Contrary to what had been observed by previous investigators, Prof. Lyle has found that the phase lag instead of continuously increasing along the bar reached a maximum value at a certain distance out, and for further distances diminished, proving thus the absence of all true wave propagation. The failure of previous observers to notice this is due to their not having been able to push their observations to as great distances as Prof. Lyle has. Thus, they never reached the critical point, and were left under the impression that the phase lag continuously increased with distance as it would in true wave propagation.

Sir William White's course of Cantor Lectures on Modern Warships is bound to attract considerable attention, and the crowded meeting which faced the lecturer last Monday evening when he started the series is only what might have been expected. Sir William prefaced his lecture with some observations to the effect that the battle of the Sea of Japan had taught naval designers nothing that they did not know before. Turning to the story of the modern warship, he traced the change from the use of iron to steel in the construction of the hulls, armour and armament, and showed by means of sectional illustrations of a modern battleship the many difficulties which confront a designer. The importance of practising economy in weight was emphasised. No more than about 38 per cent. of the total weight was allowed in the hull, whereas in an ordinary liner from 50 to 55 per cent. of the weight was so disposed. This was necessary because the dominant feature of warship design was gun armament, and everything had to be subordinated to that end. This was a familiar argument and the lecturer followed conventional lines but Sir William has the happy facility of lending real interest to even a thrice-told tale.

The Application of Mono-Rails in Underground Tramming.

By Wager Bradford.

ABOUT two-and-a-half years ago the question of the mono-rail in connection with electric telpherage suggested to me the possibility of adapting it to the requirements of underground tramming. A series of experiments was then begun, which has resulted in the successful installation of a mono-rail system on several levels in Langlaagte Deep. About 3,000 ft. of road are now in regular operation, in drives, cross-cuts, stopes and winzes, and as the system is of practical value, has possibilities which I have not yet developed, and is a radical departure from existing methods, a brief description may be of interest.

My primary object was to attain greater efficiency in tramming, by reducing friction, and correspondingly increasing the load per boy, and at the same time to prolong the life of the rail, and minimise wear and tear on the trucks. The ultimate object is to introduce motor traction on a mono-rail, pulling in trains from central loading stations, and doing away with tram boys. In this direction lie the possibilities referred to.

ADVANTAGES AS COMPARED WITH GROUND LEVEL TRAMMING.

We are all familiar with the disadvantages of the present ground level system of tramming. In filling trucks at the stope boxes there is always more or less spill, causing great friction; trucks frequently go off the track on account of the rock lying on it; in tipping at the shaft ore bins, unless tipplers are used, the truck body cannot turn clear over, and the ore, if wet, sticks to it, so that there is loss of time, and much wear and tear in the trucks to clear them; and finally, rails and wheels are not only continually exposed to the action of the mine water, which is often strongly acid, but are grinding, the one against the other, in this corrosive medium.

With the mono-rail, suspended from the roof, these troubles are minimised. Whatever the spill, no ore lodges on the track; friction is greatly reduced; trucks can with difficulty be got off the track; the truck body hanging directly over the ore bin turns bottom side up and tips clean and quickly; and, however acid the water, rails and wheels are high and dry. If it be practicable to instal a mono-rail system flexible enough to meet working conditions, stable enough to withstand the wear and tear of steady work, and at about the same cost as a ground level road, then it must make for economy.

That the system can be successfully adapted to all sorts and conditions has been fully demonstrated at Langlaagte Deep, where it is

FIG. 1 MONO-RAIL IN WINZE, OPERATED BY AIR-HOIST.

used on development work, both driving and winzing, and in tramming, both in the stopes and from the stope boxes. The accompanying drawings made from photographs recently taken, will illustrate this better than any statement. They show that the experimental stage is passed, and that the system is of practical everyday utility.

COST.

As to cost, I regret that satisfactory comparative figures cannot yet be given. Thus far, the running gear of all trucks and all the hangers, etc., have been made at the mine, and at a cost greatly in excess of that for which they could be imported. It has taken long-continued trials to prove that this or that was just right. For example, no rail suitable for a permanent road could be obtained. It should have a very deep web to give stiffness between the hangers, with a relatively narrow bead. Rails of this section are not made; the cost of rolling them specially is prohibitive; and standard bulb angles, 4½ in. deep, are now being imported as a substitute. The present roads are all equipped with 16-lb. rail, but while just the thing in a winze, this is far too light for a drive, and should be changed. Also, in the case of trucks, hangers, etc., it has taken time to arrive at the best standard pattern, and the cost of experiments have been charged against the roads erected. In future these things will be made by home manufacturers to a standard. For these reasons I must defer presenting the comparative costs to a future occasion; but it is safe to predict that the erection and equipment of a mono-rail will be little, if at all, in excess of the cost of the present system.

In installing a mono-rail above ground, the first essential is a support sufficiently rigid to carry the load, and this must be erected. In a mine, on the contrary, this superstructure, if the roof be sound, is already provided, and of the best, and the major problem is to safely suspend the rail from the roof. Minor problems

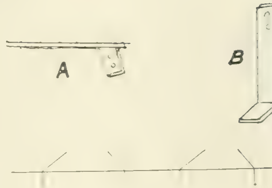


FIG. 2. HANGERS FOR MONO-RAIL.

are switches, crossings from branch lines, temporary supports in development faces, turntables, etc.

As installed at Langlaagte Deep, the mono-rail road consists of vertical iron hangers firmly fixed in the roof of the drive, winze or stope with a right angle bend 6 in. from the bottom, to form a step on which is carried a 16-lb. rail. The latter is placed at the edge of the step, to allow clearance between the vertical portion of the hanger and the truck wheels on the one side, and between the bridle of the suspended truck and the edge of the step, on the other.

HANGERS.

The hangers are made in two parts (hereinafter designated as A and B) to allow for adjustment in bringing the rail to grade. The A, or upper part of the hanger, which is attached to the roof, is made in two styles, one for drives and cross-cuts, and another for winzes and stopes.

For drives it is made of inch square iron, pointed at one end, ragged at the corners, and with a flat wing welded in an inch from the other end, at an angle of about 135 deg. Two holes are drilled through the wing to bolt on the B or lower part of the hanger. For winzes and stopes the A hanger is made with shorter shank and of lighter iron, and the wing is welded in at right angles to the shank. The B or lower part of the hanger is made of 1 in. by 4 in. flat iron, bent, as stated, 6 in. from the

bottom, at right angles, with two holes drilled through the 6 in. arm to bolt the rail to, and two near the end of the long arm to bolt to the wing of the A hanger (see fig. 2).

METHODS OF ATTACHMENT.

To attach the hangers to the roof of a stope or winze, horizontal hand holes are drilled to the depth of the shank, say, 12 in. deep; in the one case at right angles to the line of the rail, and in the other parallel to it. The hole is then partially filled with dry wood strips reaching the full length, the shank inserted, wing down, and driven well home. The stress being vertical and at right angles to the shank, the hanger cannot possibly pull out.

The attachment of hangers in a drive or cross-cut is much more difficult. Here the shape of the roof and the necessity of clearance between the trucks and the side of the drive forbid side holes. The holes must run more or less in line with the drive, making it impossible to get a right-angled pull on the shank of the hanger.

Vertical holes, well plugged, would carry a dead load of several tons, but the vibration incident to tramming tends to loosen the hangers in such holes, and accordingly the holes are put in as near a right angle with the vertical as the roof will allow, and looking in turn to and from each other (see fig. 1, C.). Adjacent holes thus look always in opposite directions, and the possibility of a hanger pulling out is minimised.

The holes are put in with machines, are 18 in. deep, 2 in. in diameter, and approximately 8 ft. apart, and are so placed that a plumb-line dropped from the centre of the hole will be 2 ft. from the footwall side of the drive. This last, to ensure the truck coming nicely under the stope boxes, and to have a clear travelling road on the hanging-wall side. A mono-rail in the middle of the drive, or zig-zagging from one side to the other, is a serious inconvenience. It should always be on the footwall side and as close as possible. Into the finished hole is now driven a perfectly dry and well-fitted plug of pitch pine to the full depth of the hole, and when it is "home," an inch round hole is bored in it to the depth of the shank of the A hanger from point to wing. The hanger is then driven home, wing down, the greatest care being taken to keep the wing in a vertical position. If this is not done the completed hanger will not be plumb. The moisture in the air swells the dry wood plug, causing it to grip the rough sides of the hole and the ragged shank of the hangers and making the road perfectly secure.

The next step is to bolt up the B hanger, but before this can be done the exact length required must be ascertained. To find this, one end of the grade stick is placed on the last completed hanger, and the other end brought to suction elevation that the grade is just right. The distance is then measured from the bottom of the grade stick to the holes in the wing of A hanger, and on this measurement the B hanger is drilled in the shop ready to bolt up.

It is a little cheaper to punch the holes, but they are not as exact, and any variation affects the grade of the road. In new work it is best to have the man developing put in the holes as he goes along, because he can do this when rigged up ready for drilling in the face, and

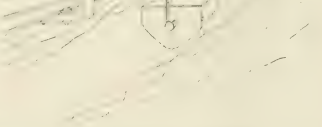


FIG. 3. MONO-RAIL IN STOPE.
Special truck body to clear floor and save taking up bottom.

thus save the cost of rigging up for two 18-in. holes. From one rigging two holes can be put up with 8-ft. centres, and a man can put up from twelve to sixteen holes per shift. It is also advisable to put up box holes as the drive advances, so that they can be holed into from the stope to save the danger of blasting the mono-rail when erected. If changing over from a ground-level road to a mono-rail, it will pay to have a machine mounted on a trolley to shift quickly along the drive.

DISTRIBUTION OF HANGERS.

The distance between the hangers is an important factor in the cost of the work. For example, 150 ft. of road would take twenty-five hangers 6 ft. apart, say, nineteen 8 ft. apart, and fifteen 10 ft. apart. Against the saving by wider spacing must be put the need for heavier rail and hangers, and the greater stress on each unit. This would become serious if trucks, of, say, one ton capacity were used. From experience, 8-ft. centres seem about right, especially if motor traction be contemplated. It would be better in each case to distribute the load over, say, twelve half-ton trucks rather than to concentrate it in six one-ton trucks; but this does not apply to hand tramming.

LAYING THE RAIL.

In laying the rail, care should be taken to break joints on the hanger, if possible, so that the end of each rail may have a bearing surface in addition to the fishplates. The hangers are bolted up with the step on the hanging wall side of the drive, and the rails are laid with the flange flush with the end of the step, and bolted securely to it through the flange. In the cross-cuts, where the roads from east and west converge, T-hangers are used, the rails from the drive being continued on each arm of the T. If the rail were carried on the footwall side of the hangers in the drives, this would not be possible, as the bridle and wheels of the trucks would then foul the T-hangers in the cross-cut, necessitating a double line of hangers and a wider cross-cut. In stope roads for which the mono-rail is particularly adapted, the rail may be laid on either the foot with hanging wall side of the hanger, but it is of advantage in narrow stopes to put it next the hanging, because the footway is thus brought lower down the stope; the tram boy does not have to stoop so much, and his work is thus made easier.

In development work, in order to keep the road well up to the face, one or more light jack bars are set up, fitted with brackets on which to lay the rail. In this way the trucks can be got right into the face, no matter what the bottom is, and the permanent rail laid as soon as it is safe to put up the hangers. When the roof of a drive is very high, or is unsafe, sticks of timber are easily made fast between walls to carry the hangers. The length of the rail should always be some multiple of the distance between hangers, and the longer the better.

CROSSINGS, ETC.

Switches, turntables, crossings, etc., are easily managed. At one station, a view of which is given, an overhead shunt shifts loaded or empty trucks from one track to another. A simple and effective switch is also shown in one of the accompanying drawings. It consists of a short length of rail, one end of which is pivoted vertically on the last hanger before the branch, while the other end is supported by a hanger sliding on a curved strip of iron fixed horizontally in the roof of the drive. There is just enough travel to allow the loose end of the rail to swing from one branch road to the other, where it is secured, as wanted, by a sliding fish-plate. This switch works perfectly, but must be moved by hand, and has the objection that one branch of the Y is always open, so that a full truck might run through into the level. To obviate this I have designed an automatic falling switch, but the objection to the open end is more imaginary than actual. It is essential for easy tramming that the grade of the road shall be very even, not up and down, especially if heavy trucks are used.

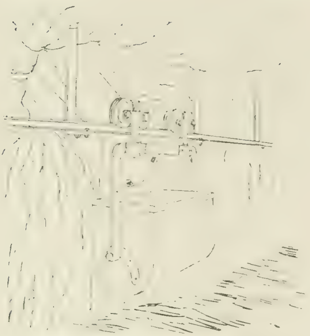


FIG. 4. MONO-RAIL AT STOPE BOX HOLE READY FOR FILLING.

The chute is of steel plate rolled shallow at upper end, and deep at the other, and hung by chains.

TRUCKS.

The trucks consist of a U or V-shaped body, hung at each end by a single pin to a bridle, which is attached in turn, by two vertical draw bars to a pair of two-wheeled bogies. There are thus four wheels in tandem. The diameter of the wheels, and the depth of the bridle, vary according to the head room. In winzes and very narrow stopes 6-in. wheels are used. In wide stopes 8 in., and in the drives 8 to 12 in.

The wheels have a flange each side, ½ in. deep, and cut away at ¼ in. taper to give a tread at the bottom of the groove of 1¼ in. This allows ⅛ in. side play, the rail head being 1⅛ in., and prevents the wheels mounting the rail on a curve. The wheel base is as short as possible, being 9½ in., with 8-in. wheels, and the bogies are set as close together as clearance will allow. The wheels of each bogie run loose on axles made fast to the bogie frame, which is welded in the centre to the draw bar, thus forming a T, of which the draw bar is the stem, with the wheels at the end of each arm. The axles are fitted with grease cups.

The vertical centre line of the draw bar of each bogie bisects the wheel base, and the lower end of the bar is made round, and flanged and held to the bridle by a loose fitting clip. The weight of truck body and bridle is thus carried on the flange of the draw bars, while each bogie moves independently of the other on a vertical axis, thus allowing the trucks to negotiate the sharpest curves with the least friction. This form of bogie was adopted after numerous experiments with other types having fewer wheels, none of which were satisfactory. It looks clumsy, but it works like a charm.

A simple catch secures the truck body in position on the bridle, and the end pins on which it swings are so placed that a loaded truck will turn turtle when the catch is released, and nearly right itself. This saves a lot of time at the ore bins, and prevents knocking trucks about. Most of the truck bodies are old U-shaped ones, holding 12 cubic ft. of ore, and were used to save expense. They are strongly reinforced at the ends to stand the extra strain where the single pin is set on, and the bridles are made big enough to take a 15-cubic ft. pan when the present one wears

FIG. 5. MONO-RAIL AT SHAFT ORE BIN.

Showing overhead shunt and method of tipping truck.

out. Special bodies have been made to hold 15 cubic feet, U-shaped for the drives, and V-shaped for stopes, and have worked well. A 20 cubic ft. truck has been tried in the drives, but the rail in use was not stiff enough to carry this load without sag between the hangers. With a perfectly rigid road, and 14-in. wheels, I think a ton truck will be readily handled by one good strong boy. Such a load will, of course, be hard to start.

In the drives and wide stopes a U-shaped truck body is preferable, but in narrow stopes a special V body, shaped to fit the floor of the stopes, is advantageous, as it does away with the need of taking up the bottom. In winzes only one bogie is used, with 6-in. wheels, and a special pan or bucket, hung by the bridle from it. Winding is done by hand from short distances, and by air winch from greater depths.

OTHER ESSENTIALS.

The truck bridles should be made just long enough to allow for clearance of the loaded body when tipping. A long bridle tends to more swing on the curves in transit, putting unnecessary strain on the road and hangers. For the same reason the road should be carried as near the roof as is compatible with clearance and even grade, since the shorter the hanger the less the lateral vibration. All roads should, however, be erected with sufficient clearance for 14-in. wheels, if required. In the present 1 in. by 4 in. hangers, the flat side being towards the rail, full advantage is not taken of the strength of material. The hanger should be bent the other way, so that the 4-in. face would stand at right angles to the rail, but such forgings are too expensive to make locally. In future it is intended to make the hangers in three sections, instead of two, as at present, the foot and roof piece being so designed that the 1 in. by 4 in. vertical portion can be bolted up as suggested, giving the maximum rigidity. No turntables have yet been erected, but one has been designed for special work, and presents no difficulties whatever. Ball bearings might

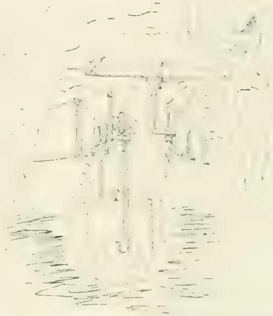


FIG. 6. MONO-RAIL SWITCH AT JUNCTION OF ROADS ADOPTED ALSO FOR CUT-OUTS.

also be used to advantage, on the trucks, if not too costly. So much for the erection and construction of roads, trucks, etc.

COMPARATIVE EFFICIENCY.

In comparing the efficiency of the mono-rail in tramming, with the ground level system, for equal distances, it is difficult to arrive at exact figures; so much depends on the personal factor represented by the tram boys, and on the time taken to fill the trucks at the boxes. The best day's work with the mono was 120 12 cubic ft. trucks trammed from an ore chute to the shaft bin, 130 ft. distant, by two boys working the ordinary shift. This would exceed thirty tons per boy, but the chute was always full, and the stuff ran freely into the truck without shovelling. The best evidence, in favour of the mono-rail, is to get behind a loaded truck and push it along yourself, and then try one with the same load and grade on the ordinary rail. The difference in effort required is striking. A long time ago Mr. Gilmour examined the mono-rail, and we walked in to the face of the drive, pushing an empty truck ahead. I suggested he should get in and when he had done so, gave the truck a push. We expected it to stop after a little

way, but it gathered speed so quickly on a 1 per cent. grade that I could not overtake it, and Mr. Gilmour rode in darkness to the station, 275 ft. distant.

Given a sound roof, and excepting abnormally wide stopes or lofty cross-cuts, it is my opinion that all underground tramming can be more efficiently done with a mono-rail than with the ground level system. In addition to the usual work of tramming from stope boxes and development faces, the mono-rail, as stated, is particularly adapted for use in the stopes themselves.

Most engineers now believe in long backs for development. It is essential with such backs to have intermediate roads, say, two, between the development levels, along which the ore may be trammed to a central point from which to be sent to the tramming level below. The system which I propose where, as in the Langlaagte Deep, two reefs are worked, is to sink central ore chutes from the upper, or South Reef workings, to the Main Reef drive below, tram by mono-rail in the upper stope to the central chute, and from the chute by mono-rail along the drive to the shaft bins. For the lower or Main Reef, a cross-cut might be run back to tap one or more central chutes in each stope.

If an intermediate ground level road is put in a stope, the footwall must be blasted up, while with the mono-rail hangers are cheaply put up to carry any load, and even in a very narrow stope, by having the truck bodies made V-shaped, the foot, except in rare cases, need not be broken. If two or more intermediate roads are used, the saving in having the foot intact is considerable, and to this is added the advantage of having a clean road. No ore lodges on the mono-rail across a stope, but with a ground level line the track will be covered as the ore is shovelled down and the traffic impeded much of the time. Where it is desired to use a gravity plane in connection with an intermediate stope road this is easily arranged by placing overhead turntables at the junction of the roads. In winzes, too, the mono-rail is much better than the other system. Rails laid on the floor of a winze are frequently buried with stuff. The overhead rail is clean, reduces friction to a minimum, brings the bucket down to the bottom, and affords an admirable hand rail for climbing up and down.

So far as my knowledge goes, until introduced at Langlaagte Deep, the mono-rail was never before used in underground work in any country. The subject of tramming has received too little attention in the past. We have been content to get along with the old methods, and in many mines of to-day ore is regularly trammed by hand from stopes a quarter of a mile, or more, from the shaft bins. The tram boy thus travels half a mile each round trip, bringing out about half a ton of ore, and spends nearly two-thirds of his time pushing empties on an up-grade. This is a great waste of energy, and should give place to improved methods.

In the first part of this paper it was stated that the ultimate object was to introduce motor traction on a mono-rail, pulling in trains from central loading stations. Where conditions admit, it seems to me there is a saving to be made by such a system of tramming in our drives, and, in my opinion, the mono-rail offers the best opportunities for the introduction of motor power.

I confidently expect to see the principle of electric telpherage applied in underground tramming, in the near future; indeed, an expert in telpherage, who has seen the mono on Langlaagte Deep, has not only assured me that the scheme proposed is perfectly feasible, but has offered to import a motor free of charge, to be paid for only if it works satisfactorily. This is getting very near to successful demonstration, and I hope this paper may induce electrical engineers to take up the problem of an efficient motor.

From a paper read before the South African Association of Engineers and slightly abbreviated.

Technical Considerations in Electric Railway Engineering.

By F. W. Carter, M.A.

THE complete determination of the engineering features of an electric railway system necessitates a large amount of careful and detailed work in order that every part may be framed adequately for its duty, no part being excessive. The labour involved in full investigation is, however, amply recompensed by the saving in capital outlay arising from the avoidance of superfluous plant, and the minimised operating troubles and smaller expenses arising from the plant being suitable and sufficient for the requirements.

The engineering problem can be, and should be, attacked in a strictly logical manner. Beginning with the requirements of the system in respect to the moving of passengers or goods, a suitable train-driving equipment is first determined. The power and energy consumption of the train is then computed, and the daily traffic estimated. Afterwards the generating plant and distributing system are laid out to suit the traffic requirements. The general process is simple, but every particular case will be found to disclose a host of special circumstances modifying the details of the engineering scheme and calling for the exercise of great care and judgment.

The chief classes of service between which it appears necessary to distinguish for the purpose of this paper are: (1) urban and suburban, (2) branch line and inter-urban parliamentary, (3) long-distance express, (4) goods. These differ in their requirements chiefly with respect to (1) rate of acceleration and speed up to which it is necessary to maintain the maximum rate, (2) behaviour on grades, (3) maximum speed attainable on level track. The chief electrical systems available for railway service are (1) the continuous-current system, (2) the single-phase alternating-current system, (3) the polyphase system employing induction motors. There are, therefore, numerous alternative combinations of service and system, many of which can, however, be disposed of when the general principles have been elucidated.

GENERAL DYNAMICS

The action of a railway motor depends practically on two variables only, and for a motor whose characteristics are known, when the voltage and current are given, the speed and tractive effort at the driving wheels are determined. The effect of the motors on the train depend upon (1) weight of train, (2) inertia of rotating parts, (3) train resistance.

The weight of train to be employed in calculating the acceleration due to any force is a certain spurious "effective weight," composed of the true weight and an increment due to the rotation of the wheels and armatures. This increment is not difficult to obtain.

In the case of suburban trains operated by continuous-current motors, the amount to be added on account of rotary inertia will usually be some 8 or 10 per cent. of the weight of the train, whilst with single-phase alternating-current motors the increment may amount to double as much, on account of the greater number and weight of armatures and their generally higher peripheral speed.

There is a lack of reliable data on the resistance offered to the motion of electric trains, which it is hoped will soon be supplied. Pending the publication of more suitable data, the author has combined the results of certain tests to obtain the working curves of fig. 1, which he has found to agree very fairly with the results of such isolated tests on electric trains as he has been able to make. The total train resistance is the amount deduced from the curves of fig. 1, increased by $2\frac{1}{2}$ to $3\frac{1}{2}$ lb. per ton.

A light train of given external dimensions will, except at low speeds, meet with almost as great resistance as a heavier-built one of the same dimensions. A train of many coaches experiences much less resistance per coach or per ton than one of two or three coaches, particularly at high speeds. These facts are allowed for in the curves of fig. 1.

Of the energy supplied to the train, part is dissipated in motors and controlling apparatus, part is employed in overcoming train resistance, whilst the remainder imparts kinetic energy to the train and is dissipated during braking. The proportions of the several components are shown in fig. 7 for typical suburban service employing continuous-current motors. The energy required to overcome train resistance amounts to [illegible] two watt-hours per ton-mile for every pound per ton train resistance. The kinetic

energy dissipated during braking varies as the effective weight of the train, and as the square of the speed when brakes are applied. The energy dissipated in motors and gears will be some 10 or 12 per cent. of the input, whilst from 0 to 12 per cent. will usually be dissipated in starting rheostats. In the single-phase system the losses in motors, gears and controlling apparatus will usually be at least as great per ton mile as in the motors, gears and rheostats of the continuous-current system, chiefly on account of the much lower efficiency of the motors. It will be seen from fig. 4 that the energy consumption is considerably affected by the rate of acceleration, particularly when stops are frequent and speeds high.

Whilst discussing energy consumption it might be well to issue a warning against the abuse of the ton-mile basis. As long as we deal with a particular system of electrification, the energy consumption is well expressed in watt hours per ton mile, but in comparing different systems with one another it should not be overlooked that the weight of train incident to a system is also a factor in the energy consumption.

The continuous-current railway motor is characterised by the fact that within the limits of practicable and efficient operation it has a large range of torque and a moderate range of speed. As usually geared, it is possible to obtain a torque of ten to fifteen times that required to overcome the train resistance at the maximum speed attained on the level, the high torque being maintained until the speed reaches approximately a half of the maximum. Fig. 2 shows these characteristics for a typical continuous current railway motor.

SINGLE-PHASE WORKING.

Single-phase alternating-current railway motors are of two general types—the compensated series and the

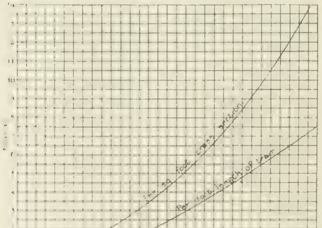


FIG. 1 — [illegible] curves giving the variable component of train resistance

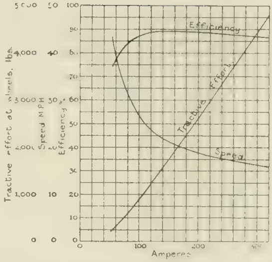


FIG. 2 Characteristic curves of a continuous-current railway motor

repulsion type. Both types show the same general speed-torque characteristics—the range of torque being considerably smaller and the range of speed somewhat greater than in the continuous-current railway motor.

Fig. 3 shows typical speed and tractive effort curves for the continuous current, the single-phase alternating current, and the polyphase induction motor. The scale of co-ordinates is arbitrary, and in comparing the several motor types together, the abscissa or ordinate of any curve may be supposed increased or diminished in such proportion as may be desired to render the comparison suited to the class of service considered.

Knowing the train resistance, grade, and tractive effort of the motors at any speed, we can deduce the tractive effort available for producing acceleration, whence—from the effective weight of the train—the rate of acceleration. It is now a question of simple dynamics to deduce speed-time and speed-distance curves, whilst from the motor characteristics the power-time, current-time and other train characteristic curves may be deduced.

The typical schedule run may be divided into four elements, corresponding respectively to (1) acceleration to the speed curve, (2) speed curve running, (3) coasting, and (4) braking. Since any of these elements can be varied, it follows that a run can be made in many different ways. However, for any particular type of motor, if average values be assumed for the amount of coasting and the rate of braking, the remaining variables can, for practical purposes, be expressed in a system of curves, from which the particulars and performance of the train can be deduced. Such a system of curves for continuous-current motors as employed in suburban service is shown in figs. 4 and 5, and these will be found useful and sufficient for preliminary calculations.

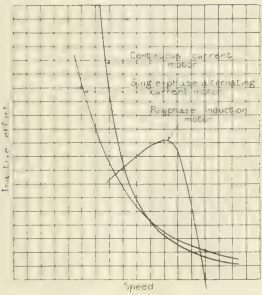


Fig. 5.—Comparative speed and tractive-effort curves of railway motors.

Fig. 6 shows typical train characteristics of this system corresponding to acceleration at 1.5 miles per hour per second. The three curves are of the same area, and the distance represented will be found to be one mile divided by the number of stops per mile, as of course it should be. In order to understand the reason for choosing the co-ordinates employed, suppose a particular run is made in t seconds, the distance being d and the number of stops per mile n, so that nd = 1 mile. Let the speed at any point be [illegible].

Next, consider a run in which both time and speed are changed in the same proportion, x, so that the curve retains its shape but merely varies its linear dimensions in this proportion. The area will vary as x^2. We may therefore write [illegible]

But [illegible] d' [illegible] d
nd [illegible] d'.

[illegible] n [illegible] $\sqrt{\frac{n}{n'}}$

[illegible] $\sqrt{\frac{n}{n'}}$

accordingly [illegible] $\sqrt{n}$ [illegible] $\sqrt{n}$

and [illegible] $\sqrt{n}$ [illegible] $\sqrt{n}$

It follows, therefore, that if we take time [illegible] $\sqrt{n}$) as abscissa, and speed [illegible] $\sqrt{n}$ as ordinate in fig. 6, all speed-time curves having a definite shape will be reduced to a single curve, and all such runs will be represented by a single point on the curves of figs. 4, 5 and 7. This method of treatment was pointed out to the author by Mr. [illegible] of the General Electric Company, who has employed it in deducing general curves for [illegible], somewhat on the lines of figs. 4 and 5.

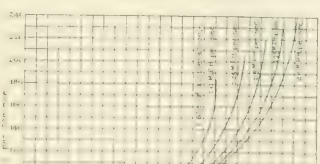
Referring again to fig. 6, and considering a speed-time curve of definite shape, the power required at any point will vary as the speed, and, therefore, inversely as $\sqrt{n}$. The energy consumption per run, varying as the power and as the time, will vary inversely as n. The energy consumption per mile, being n times the energy consumption per run, will be independent of n, and depend only on the shape of the speed-time curve. Accordingly fig. 4 gives energy consumption directly in watt-hours per ton mile.

Fig. 7, showing how the energy input given by one of the curves of fig. 4, is finally dissipated, practically explains itself.

The power output of the motors during a run is very variable. It starts at zero and rises with the speed during the period of acceleration on resistance. Then, with the speed still rising, but more slowly, it falls off continually due to decrease of tractive effort. The maximum power will be developed at the instant when all resistance is cut out, with motors in parallel—that is, when the motors are taking the accelerating current at full voltage. This is the power plotted in fig. 5

SERVICE CAPACITY OF MOTORS.

There does not at present appear to be a general agreement as to how railway motors should be rated. There is no practicable and simple method of rating a railway motor competent to express its real service capacity, and it is only by experience in actual service or by suitable service tests that the sufficiency of a motor for its duty can be determined. Service tests do not take account of all the circumstances incident to actual service, but they nevertheless form a satisfactory basis for an estimate of service performance.



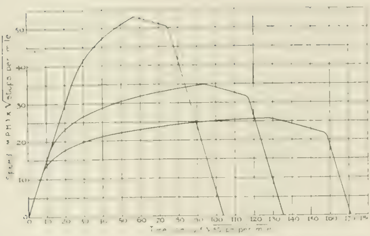


FIG. 6.—Typical train characteristics for trains operated by continuous current.

The appearance of the resulting curves for a service test of a large railway motor is shown in fig. 8.

In making use of the thermal characteristic curves to determine the temperature rise in a motor proposed for a particular service, the average values of armature and field coil loss are calculated for the cycle of operations which the service involves. From these, the ratio of distribution is deduced; from the thermal characteristics, the temperature rise per watt loss; thence and from the losses we finally obtain the actual temperature rise of both armature and field coils.

The design of the motors should be such that for a service involving frequent stops—where they take the accelerating current for a considerable fraction of the time that power is on—the field coil temperature is the higher, whilst in a service involving much free running the armature temperature should be the limiting feature.

Fig. 9 is deduced from fig. 8, and expresses the thermal characteristics of the motor in a different manner. It shows the total electrical loss which causes a limiting temperature rise in field coils or armature of 75° C. There is not a very large variation in energy loss for different classes of service, and as a first approximation one might affirm that, with a given frame, and a definite arrangement of perforated covers or other heat-dissipating devices, the permissible electrical losses are definite. A motor dynamically capable of a given service will therefore be suitable for continuous use on that service, provided the permissible electrical losses are not exceeded. These losses in a continuous-current railway motor of good design and considerable power usually amount to between 6 and 7 per cent. of the input.

The study of service capacity is of the utmost importance to the designer, who is thereby guided to arrange that the dynamical capacity of a motor shall correspond with its service capacity when used in the class of service for which it is designed, and to so distribute the losses between armature and field coils that they rise about equally in temperature in average service.

TRAFFIC.

Having finally settled upon the driving equipment and determined the maximum and average power taken by a train, it becomes necessary to make the best possible estimate of the amount of electrically operated traffic upon all parts of the system at all times, in order that the generating and distributing systems may be devised to suit the duty to be imposed upon them.

A very useful curve can be obtained from the time-tables of a steam road, by plotting the number of trains in service as ordinate against time as abscissa. Such a curve for a certain London suburban service is shown in fig. 10. It may be taken as showing the probable general shape of the power-house load curve, no account, however, being taken of the variations in load at starting a train or cutting off power. If we are able to make a good estimate of the mean power required under electrical operation at the time of heaviest traffic, we can, by comparison of ordinates, infer approximately the power required at any other time.

Fig. 10 is a typical traffic curve for London suburban service under steam operation. We will here give some further particulars of the traffic represented:—

Total hours of service, 20.5; maximum number of

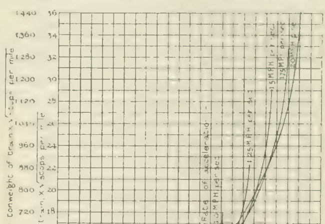


FIG. 7.—Power and weight [illegible]

trains running, [illegible]; total train miles per day, [illegible]; total train-hours per day, [illegible]; total train hours per day, 210; hence schedule speed, m.p.h., [illegible]; and average number of trains running, [illegible].

It will be seen that the average number of trains running is only [illegible] per cent. of the maximum. The

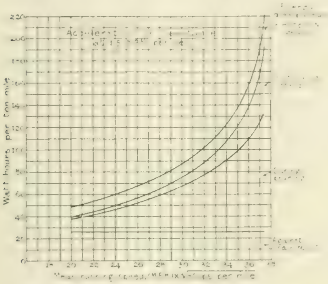


FIG. 7.—[illegible]

average during the time [illegible] is approximately [illegible] per cent. of the maximum.

In such a system [illegible] expect [illegible] 27 trains in service, three [illegible], and [illegible] undergoing renovation or repair, making a total of at least [illegible] trains allocated to the service. Each of these [illegible] trains, therefore, [illegible] average of 115 miles per day, whilst the 27 [illegible] average of 136 miles each during the day.

The above applies particularly to steam [illegible] but, it [illegible] the load [illegible] the same railway when operated electrically.

DISTRIBUTING SYSTEM.

The above [illegible] the maximum. With [illegible] return, however, there are the additional [illegible] in uninsulated [illegible]

[illegible]

the [illegible] and the voltage drop in the conductor rails at any particular time determined [illegible] of heavy load, and the worst condition to be anticipated in regular service should be judged, due allowance being made for probable future increase of traffic.

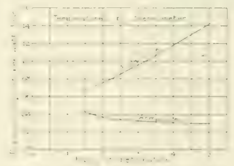
The output of the substation may be taken as 5 per cent. in excess of the input to the trains. The maximum momentary output may generally be taken as occurring when two trains are taking their maximum accelerating current and all other trains that can possibly be supplied from the substation are taking their average current.

In the case of rotary converter substations, the total capacity of the installed machinery will usually be some 40 or 60 per cent. greater than that installed in the generating station for supplying power to the trains.

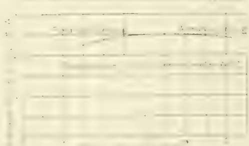
In a continuous-current system the all-day efficiency of distribution from generating station busbars to trains is usually in the neighbourhood of 75 per cent. In a well-designed alternating-current system this efficiency would probably approximate to 87 per cent.

GENERATING PLANT.

By means of the traffic curve of fig. 10, combined with estimates of the maximum probable traffic under



[illegible]



[illegible] way motor.

[illegible] traffic, which [illegible]

by the mean power required during the highest peak of the load.

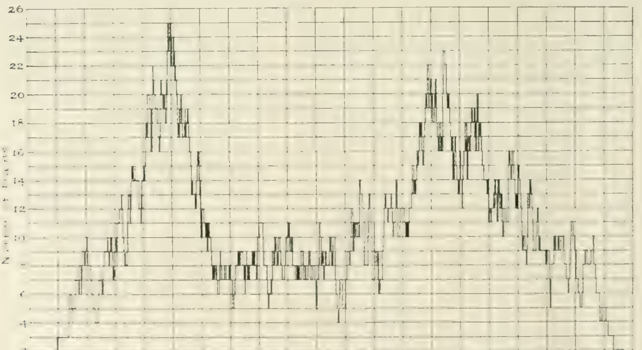
ALTERNATING CURRENT WORKING

The most valuable features of alternating-current operation are consequent upon the possibility of supplying power to the trains at high potential. This makes practicable the use of much lighter line conductors than can be employed under continuous-current operation, and also requires fewer substations for a given loss in the line conductor network.

The use of the track or other insulated return circuit for the current requires consideration. The author has no information as to what amount of electrolytic corrosion is to be expected from alternating earth currents as compared with continuous, or what regulations are likely to be imposed to prevent damage by such currents. It is not, however, desirable to impose a limit to the difference of potential between points on the uninsulated return unless the method of measuring the voltage is very precisely set out. If the voltmeter be joined to two points in the conductor by pilot wires lying very close to the conductor, the voltage indicated will be little more than the CR drop. The alternating flux due to the current in the conductor will for the most part cut the pilot wire and produce an e.m.f practically neutralising the reactance drop; thus the indication of the voltmeter will be the difference of potential diminished by this e.m.f. In order to indicate the true difference of potential between points on the conductor, the pilot wire should lie on the surface separating the lines of force which close about the trolley wire from those about the return conductor. This is practically the horizontal plane at a height from the ground equal to a half the height of the trolley wire. Fig. 11 gives the indicated voltage for the particular case of two copper wires, each of one square inch cross section and 200 inches apart, and shows that the true difference of potential between any two points on one of the wires, at a frequency of 25 cycles, is in this case more than seven times the CR drop, although readings anywhere between one and fourteen times can be obtained according to the position of the pilot wire.

The best arrangement of boosters is probably that of the Oerlikon Company, in which the track current is transferred by the boosters to a common return conductor running between substations. It is possible, however, to do without the return conductor by connecting the secondaries of the boosters across insulated joints in the track and introducing a small equalising wire as shown diagramatically in fig. 12. With this arrangement the track rails are employed as return conductors. The boosters must, however, be closer together near the substations than in the Oerlikon system, and a greater number are accordingly required.

There is much of a general nature to be said in favour of the single-phase alternating-current system,



and the author, in common with many others, founded great hopes on its development, believing that it would lead to a considerable increase in the electrical operation of railways. Careful investigation, however, reveals difficulties and disadvantages which compel the conclusion that the single-phase system as at present developed is not suited for a great part of the railway work likely to be required in this country (*i.e.*, urban and suburban work), and, moreover, shows no prospect whatever of being rendered satisfactory for the purpose.

Under suburban conditions, the single-phase system compares very unfavourably with the continuous-current system. What with the heavier train and the greater energy consumption per ton mile, the energy consumption per train mile, for trains of given capacity, will generally be quite 45 per cent. greater under single-phase than under continuous-current operation. Allowing for the higher efficiency of distribution in the former of these systems, the power and energy generated must still be some 30 per cent. greater. This requires 30 per cent. greater capacity in the generating plant, the cost of which will almost wipe out the saving in the substations, whilst the 30 per cent. greater annual generating costs will far exceed any possible saving in substation maintenance and supervision. A properly installed overhead conductor system, insulated for high potential, will be at least as costly as a third rail, whilst the single-phase train equipments will be two or three times as expensive as the continuous-current equipments for corresponding trains. In fact, taking account of all circumstances, the single-phase system, when compared with the continuous-current system on the basis of equal traffic, requires a considerably greater capital and considerably [illegible] to operate in the class of service under [illegible].

The test of good engineering is ultimately a financial one. A certain result must be attained by such more or less prescribed means as will produce the greatest return on the [illegible] outlay. An increase of capital expenditure is, therefore, only justified if it be an improvement in results or decrease in expenses, or

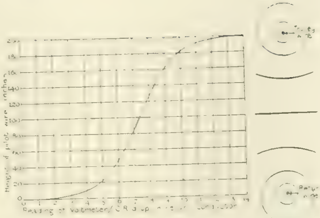


Fig. 11.—Apparent voltage drop in return conductor, using alternating current.

adequate return results. No such claim can be made on behalf of the single-phase system as compared with the continuous-current system in suburban service, and, unless prescribed limitations form a bar to the employment of the latter system, the former must be condemned.

POLYPHASE SYSTEM.

The polyphase system, employing induction motors, has the disadvantage of requiring two or more overhead conductors, which complicates matters considerably at junctions, although it is not so serious an objection on continuous track. It is not well suited for suburban or other service in which stops are frequent and a high rate of acceleration necessary. With tandem-parallel control about one-third of the input during the time of controller acceleration is wasted in the stats, and since controller acceleration is continued until practically full speed is reached, after which the power required is small, the waste in the stats is nearly one-third of the whole input if stops are frequent. It is true that some of the energy of the moving train can be recovered when stopping, but only by imposing extra duty on the motors and so diminishing their service capacity. There is not the long range of efficient speeds on free running which characterises the continuous-current motor, the change from accelerating to free-running being almost sudden. The equipment weight, moreover, for suburban service is almost as high as in the single-phase system.

The strong feature in the polyphase motor, as compared with that of other systems, lies in the absence of a commutator, whereby the most frequent source of trouble is avoided. The motor is a good mechanical apparatus, with nothing particular to get out of order, and one could afford to sacrifice many advantages for

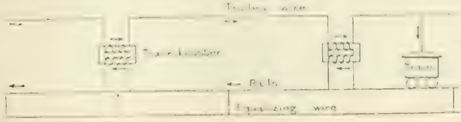


Fig. 12.—Track booster system for alternating current operation.

the sake of employing such a motor for train driving. The weakest feature lies in the small air-gap necessary, which requires exceedingly good and well-designed bearings. These, however, can be provided without difficulty. A mountain line can be satisfactorily operated by polyphase motors, since the continuous grades furnish a sufficient load, and there is no need to carry excessive motor capacity to provide for acceleration.

In fairly level country, goods or other service, in which stops are infrequent, and the acceleration therefore of small importance, might very well be operated by the polyphase system. High-speed long-distance service is particularly suitable, the high train resistance making the grade resistance of relatively smaller importance, so that during free-running the motors can be arranged to operate near the load of highest efficiency.

CONCLUSIONS.

The chief immediate developments in the direction of railway electrification are to be looked for in urban and suburban districts.

Taking all things into consideration, the continuous-current system appears by far the most suitable for suburban service in this country, and there are no present indications that it is likely to be superseded for this class of service.

When we depart from suburban conditions and begin to consider classes of service in which the traffic is less dense and stations less frequent, we cannot formulate general rules as to the best system of operation, or even assert that electrical operation is good engineering. Each case as it arises must be considered on its merits, and a full technical investigation of the problem presented is necessary before any definite conclusion can be arrived at. A class of traffic for which electrical operation might be expected to show to advantage is inter-urban passenger traffic, handled on the same lines as on the American inter-urban railways, i.e., with single cars or small trains running at fairly high speeds and at frequent intervals. Such districts as South Lancashire or the South Staffordshire black country offer excellent facilities for this class of service. Where stations are fairly close together, the continuous-current system will probably be found most suitable for this class of work, especially if the [illegible] forms a [illegible] network. The overhead [illegible] has advantages in industrial districts where there are a large number of goods-sidings whose [illegible] add to the difficulty and [illegible] installing a third rail. Where stations are [illegible] two or three miles apart, and the elec[illegible] [illegible] complicated [illegible] could [illegible] instances be made for the polyphase system. In general, however, it is probable that the single-phase system would be found the more advantageous for such work.

Another class of service for which electrical operation might well prove desirable is that on branch lines, where in many cases the traffic is not in itself sufficient to pay expenses, but is necessary to put country towns in communication with the main lines. These should be run as inter-urban tramways, operating a fairly frequent service of single cars or trains of two or three coaches and employing overhead line conductors.

The best system of operation is a matter for investigation in particular cases, depending on considerations already discussed. It may be mentioned, however, that in the case of newly-projected lines intended entirely for this class of service, there is some advantage in adopting the continuous-current or the single-phase system, since very little grading is required if either of these systems is employed, the motors being capable of operating efficiently on much steeper grades than could be permitted in steam service. The light agricultural railways under consideration in some quarters should undoubtedly be electrically operated.

In a few places, such as between Liverpool and Manchester, and between Leeds and Bradford, it might be possible to inaugurate a very high-speed service on the lines indicated by the Marienfelde-Zossen tests, although it is a little doubtful whether the saving of time possible in these comparatively short distances would form sufficient inducement to create a paying traffic.

The operation of our main-line trains would not be sensibly improved by electrification; certainly no such improvement would be anticipated as would justify the necessary great outlay of capital.

There is one consideration, however, which may become important on some sections of line, and this is that, with the limiting load gauge given, it is possible to obtain considerably more power from an electric than from a steam locomotive. The power practicable within the loading gauge imposes a limit on the trains which it may sometimes be desired to extend.

No particular advantage would in general accrue from the electrical operation of goods traffic. At docks, goods-yards, and like places, however, where there is much shunting, if there is an existing generating plant for supplying power to cranes, capstans, etc., it would undoubtedly be advantageous to employ electric locomotives in place of steam. In some such localities the use of overhead wires would be objected to, and some form of surface-contact system would probably be found necessary.

Abstract of paper read before the Institution of [illegible] Engineers.

No. 2 UNIVERSAL TOOL GRINDER.

BY THE CINCINNATI MILLING MACHINE COMPANY.

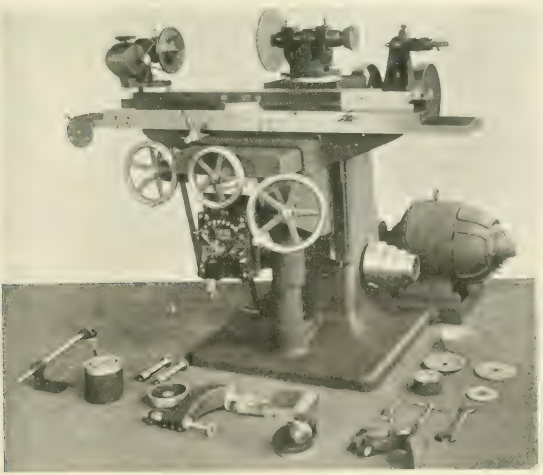
The grinder illustrated herewith is a convenient machine for the general [illegible] of cylindrical, internal, disc, and surface grinding required in tool making, and in manufacturing small machine parts.

The centres swing 12 inches and take 30 inches in length. There are [illegible] changes of automatic feed for each spindle speed, ranging from [illegible] inches to [illegible] inches per minute. The swivel head has No. 12 B. and S. taper hole for holding cutters on their own shanks for grinding, and will take face and side-milling cutters up to 24 inches diameter, [illegible] inch face grinding three sides of blades without rechucking.

The spindle is of tool steel and runs in phosphor bronze boxes adjustable for wear. The speeds are 4 in number: viz., 1,800, 2,300, 3,100, and 4,300 revolutions per minute. The table is [illegible] inches long — has a ⅝-in. T slot, and swivels about a fixed centre; it has graduated arc reading in degrees, and a scale at end reading up to 2 inch taper per foot. It can be lowered 12 inches below centre of emery wheel spindle.

For surface grinding it will take work 7 inches by 24 inches on table. The swivel vice has jaws 4 inches wide, [illegible] inches deep; opening [illegible] inches; while the internal grinding attachment will finish holes ¾ inch diameter and larger by 4 inches deep. It has [illegible] speeds, from [illegible] revolutions per minute to 19,000 revolutions per minute. Internal grinding can also be done by an extension on main spindle, which will grind holes [illegible] inch diameter and larger by 5 inches deep.

The net weight of complete machine with countershaft is about [illegible] lbs., the net weight with motor being about [illegible] lbs.



No. 2 Universal Tool Grinder.

Our Weekly Biography.

PROFESSOR JOHN AMBROSE FLEMING, M.A., D.Sc., F.R.S.

Professor of Electrical Engineering in University College, London.

DR. J. A. FLEMING, who recently concluded a course of Cantor lectures before the Society of Arts, dealing with the "Measurement of High-Frequency Currents and Electric Waves," has won not a little reputation as a lecturer on scientific subjects. He was born at Lancaster in 1849. Educated at the University College School, London, with view to becoming a mechanical engineer, he matriculated at the University of London, and in 1866 became a student in the Faculty of Science, graduating B.Sc. in 1870.

From 1873 to 1874 he was a demonstrator in the laboratories of the Royal College of Chemistry and private assistant to the late Sir Edward Frankland. At the inaugural meeting in 1874 of the Physical Society of London he read the first scientific paper on the subject of the "Contact Theory of the Galvanic Cell." The same year he was appointed lecturer on physics and chemistry at Cheltenham College. Three years later he relinquished that position and proceeded to St. John's College, Cambridge, where, working under Professor Clerk Maxwell, in the Cavendish laboratory, he carried out an exhaustive series of researches comparing the existing British Association's Standards of electrical resistance with the object of determining their difference at different temperatures, and determining the mean British Association ohm.

After a brilliant career at Cambridge as exhibitioner, prizeman, and foundation scholar of St. John's College, he took the Doctor of Science degree of the University of London in 1870, and was appointed University Demonstrator in mechanism and applied mechanics in the engineering laboratory of Professor James Stuart. When in 1881 the Nottingham University College was opened as a centre for university teaching and technical education, Dr. Fleming was selected out of a large number of candidates as the first professor of mathematics and physics. But after a short tenure of office, he removed to London on appointment in 1882 as electrician to the Edison Electric Light Company. On the amalgamation of the Edison and Swan Companies in 1883 he retained the position of advising electrician to the united company, and has since been intimately associated with the development of electrical engineering.

In 1883 he was elected a Fellow of St. John's College, Cambridge, and the following year, from the London University, he was the recipient of a like distinction. The Council of the University College, London, resolved in 1885 to establish a chair of electrical engineering and Dr. Fleming was appointed professor. At that period the College possessed no properly-equipped electrical laboratory, but the new chief was an enthusiast, and the organisation of this new department gave him an excellent opening for his inexhaustible energies. In 1892 the Council decided upon the erection of the new electrical and engineering laboratories, and Professor Fleming was responsible for the design of all the interior arrangements of the electrical engineering part of the building.

Outside the limits of his academic work, Professor Fleming is well known as a public lecturer; for many years he was a Gilchrist lecturer, and has delivered several courses of Cantor lectures before the Society

of Arts. At the Royal Institution, in addition to several courses of afternoon lectures on the induction coil, electric illumination, magnetism and wireless telegraphy, and two courses of Christmas lectures on the work of an electric current and on waves and ripples in water, air, and æther, he has given Friday evening discourses on many subjects, including the physics of an electric lamp, electro-magnetic repulsion and electric qualities of metals at low temperatures. Among his best known books are The Alternate Current Transformer in Theory and Practice, Electric Lamps and Electric Lighting, and The Handbook for the Electrical Laboratory. Besides teaching, lecturing and authorship, Dr. Fleming has found time for the prosecution of much original research, the results of which are recorded in the pages of the proceedings of the Royal Society, the Institution of Electrical Engineers, and other places.

Photo: [illegible]

PROFESSOR JOHN AMBROSE FLEMING, M.A., D.Sc., F.R.S.

He was elected a Fellow of the Royal Society in 1892. The papers he read before the last-named institution on the necessity for an central standardising laboratory for electrical instruments in 1885 is generally allowed to have given the initial impetus to a movement which resulted in the establishing of the Board of Trade Electrical Laboratory, and the National Physical Laboratory. Dr. Fleming practises as consulting electrical engineer, and, as electrical adviser to several corporations and firms, has taken a considerable share in the development of electric lighting. He has frequently acted as arbitrator in electrical disputes, and has for nearly a quarter of a century been closely connected with electrical expert matters, in which character his advice is frequently sought. He has always taken an interest in questions concerning popular education, and the movement which resulted in the establishment of the Morley Memorial College for working men and women was one in which he had a considerable share.

Altogether about sixty scientific papers have been published by Professor Fleming in the proceedings of various learned societies. Many of these, on the subjects of alternating currents, photometry, wireless telegraphy, and allied topics, have had an important influence on the development of the branch of industry to which they are applied.

His Cantor lectures on "Hertzian Wave Telegraphy," delivered in 1903, before the Society of Arts attracted large and distinguished audiences, and the published lectures have been translated into German and Japanese, and republished in the United States.

Since 1899 he has been closely connected with the practical development of wireless telegraphy as consulting associate with Mr. Marconi.

The Technical Training of Apprentices.

By Professor W. Ripper.

THE report just issued by the Council of the Association of Technical Institutions on "The Co-operation of Employers in the Technical Training of Apprentices," makes clear the extent of the progress which is being made throughout the country in the provision of the means of technical instruction, and shows how surely, even if somewhat slowly, employers are beginning to recognise the value of the schools and institutions, and the importance of their making the best possible use of them.

It is now no longer a question of providing educational facilities. It is rather a question of availing ourselves to the full of those we already possess, and of showing as far as we are able some of those results and fruits which may reasonably be expected from them.

It is to be noted that the inquiry upon which the report is based was largely if not chiefly concerned with evening students. One reason of this no doubt is, that so far it is for evening students that most of the co-operative schemes have been arranged.

It is true that the council in their report have not dealt by any means with all the numerous examples in the country of the co-operation of employers in the technical training of their workers, but the examples given suffice to illustrate some leading and highly suggestive cases, which are well deserving of more general imitation.

My own observation and experience, as is no doubt the case with many members of the Association, lead me to believe that the unsympathetic attitude towards technical education which used to be so common among foremen and employers in this country is undergoing a rapid change, but it is certainly not yet the experience of all, and the circulation annually of a short report by the Association recording progress on the part of employers in the direction of sympathy with the schools and of co-operation with their work should greatly help to bring about a more healthy and helpful state of affairs.

The encouragement offered by employers to apprentices takes several forms, which naturally vary according to circumstances, but I would suggest that there is no form of encouragement comparable in effect with that which makes admission of youths to the works and promotions of apprentices in the works dependent, at least to some extent, upon their educational attainment.

The apathy and indifference towards educational improvement so general among apprentices and young people will be largely removed when they are made to realise that there is, as a rule, no promotion for them unless they are able to show that they possess educational as well as practical fitness for such promotion.

This method of promotion is the one exclusively adopted in the Government dockyards, and the results of it have without doubt been highly satisfactory.

In the admirable schemes of Messrs. Vickers, Sons and Maxim, at their Barrow-in-Furness works, they say that "preference will be given to lads possessing technical training in making appointments of trust in their works, such preference, however, not to be taken to act to the exclusion of any person who is, in the opinion of the firm, fitted for promotion."

Personally, I have long been of opinion that if employers did nothing more in the direction of the encouragement of education among their young people than to make admission to, and promotion in, their works dependent in in some measure upon educational merit, we should find that a great impulse would be given to study, at least among the more ambitious youths, and a higher general standard of intelligence would result.

Many firms go much further than this and offer pecuniary inducements in the direction of increased wages for success in evening classes. Where this is done, there is no doubt that it is not generally from philanthropic motives, but because the firms are satisfied that it pays them to do so. By such means they find out their more competent young men, and they eventually surround themselves with a better trained and more intelligent class of workpeople, from which also they are able to recruit, with advantage to themselves a more capable staff of subordinate leaders.

A somewhat common method in American works of keeping a careful eye upon the educational work of apprentices is to appoint a senior draughtsman, or other responsible person, as special superintendent of apprentices, whose duty it is to watch their attendance and progress at the schools, and to report the result periodically to the heads of the firm.

That the attention of employers to the education of their young people pays, and pays well, both directly and indirectly, is a lesson employers are beginning to learn. All are ready to admit the importance of keeping pace with the times, and of having the most up-to-date and highly efficient and productive machinery, but we have yet very much to learn as to the value of the man behind the machine, and as to the importance not only to himself, but to his employer of his being efficient and in the best possible condition both physically and mentally.

In the race for commercial supremacy England, America and Germany are each, probably, equally well equipped with the most up-to-date machinery and appliances. But these are tools merely. For the real element of success for the intelligence and virility behind the tools, we can depend only upon the quality of the individual men from top to bottom of the industrial army; and especially do we depend upon the quality of the men at the top—the leaders—whose character, ability, foresight, judgment, power of organization, and power of inspiration must ultimately determine the degree of success of the efforts of the whole.

Our experience in the past is that many of the men most worthy and most competent to become leaders are men from the ranks of the workers themselves. The surest way to discover these men is by such means as employers are now adopting for the education of their apprentices.

In this way many youths whose ability would otherwise have been lost to their employers, and to the nation are secured, and prepared to fill positions which their inherent ability qualifies them to fill.

It is of the utmost importance that facilities should be available to enable the most promising students of the apprentice class to go forward by means of scholarships to more advanced courses of instruction in day institutions. In many centres such scholarships already exist. The Whitworth Scholarships and the Royal Exhibitions and National Scholarships have been and still are productive of immense good, but there is still room for further help in the same direction.

This brings me to the subject of the day classes in technical institutions, and to the relation of employers to the young men who are receiving an advanced course of training in them.

At present there is too often no connection whatever between the works and the technical school no knowledge on the part of the

employer of the quality of the youths in the colleges, who are available for suitable employment, and on the other hand no opportunity on the part of the youths to show possible employers what qualifications they possess, and what claim they have to recognition over the youth who has received no training. It is rue that generally speaking all students who pass through our institutions immediately get into some sort of employment, but it is by no means certain that the best men get the best places, and this is one very important reason why it is desirable that there should be a closer relation between the employer in need of the well-trained assistant, and the capable student who is on the look-out for an employer. A closer relationship between employers and the teachers in technical institutions is therefore demanded in the interests both of public efficiency and of private well-being.

At present the technically trained student has still his reputation to make. Many employers look askance at him, and if they offer him employment expect him to begin at the bottom and to start at the same wages as the youth who has never received any training at all.

I have known students who have completed a three years' course, and who have been among the distinguished students of their year, started in a works at a few shillings a week, set to do the most menial tasks, and kept at the same simple job for months, without the slightest indication of any regard for the training through which they have passed.

I have known students who, when applying for an appointment, feared to mention that they had been trained in a technical institution lest they should lose the position they were trying for. They have said: " We will get the place first and then we will show what we can do." And it may be added many of them have shown what they could do, and have rapidly been entrusted with important duties.

On the other hand, many employers, particularly those who are themselves men of education and training, appreciate the value of the technically trained student, and are willing to recognise at once that such a youth should be capable of doing better work and should be worth more than one who has not been trained. With such employers the student is soon carefully weighed in the balances, and it must be confessed, he is sometimes found wanting. The employer is of course fully entitled to expect his assistant at least to be accurate and reliable, when set to do work which his training is supposed to have specially fitted him to do. If he succeeds, all is well, and if to this, he shows himself capable of initiative, and of assuming high responsibility, his progress is assured. If, however, he fails in the matter of accuracy, or if he is wooden and slow, and deficient in initiative, then his opportunity is lost, and unfortunately the reputation also of the training is probably lost at the same time.

It might be as well perhaps to point out that not every student who has attended a technical institution carries with him a guarantee of fitness for the work he undertakes to do. Many students attend technical classes and pass out utter failures from the educational and every other point of view, although afterwards they do not fail to make what capital they can out of the fact of their attendance at the said institution.

But it may be urged on behalf of the good student, who perhaps at first does not make a good impression, that however competent he may be as a student, if he is a sensible fellow he knows that he has much to learn which cannot be learnt from books, and that he has many limitations and deficiencies which only time and practical experience can remove. The considerate employer knows all this also, and is willing to make allowances for it, and providing the student does not put on "airs," the employer will not at first expect too much of him.

Notwithstanding his limitations, the best type of technically trained student has found his way into every department of the skilled industries, and he is, indeed, becoming more and more indispensable to such industries.

To him the manufacturer looks for help to meet the needs of the present, and for initiative and resource to tackle boldly the problems of the future.

It is the duty and business of the technical institutions to see that the expectation of the manufacturer is realised in ever-increasing measure.

Finally, I can conceive of no more important object for the Association, and for all the individual members of it, than to do all that can be done to assist in bringing about this most desirable entente cordiale between employers and technical institutions.

THE BEST METHOD OF ARRANGING THE PERIOD OF COLLEGE AND WORKSHOP TRAINING FOR TECHNICAL DAY STUDENTS.

The following remarks deal with the much-discussed question as to the best course for the would-be day student in a technical institution to follow, whether he should enter the works first, and afterwards proceed to the technical college; whether he should enter the technical college direct from school, and after his college course proceed to the works; or, thirdly, whether he should follow the works training and college training concurrently, by alternating attendance of six summer months in the works and six winter months at the college.

My own view is that the best method depends very much upon the circumstances and conditions of the student himself. Much can be said in favour of each of the above methods, and each in turn may be best according to circumstances.

I.—In favour of attending the works first, at least for a short period, it may be claimed:

That an early contact with the skilled workman, and the knowledge thereby obtained of the workman's habit of thought and point of view, will teach the student to appreciate his merits and qualities, and will provide a personal experience of him which will be an excellent preparation for the management of men in the future.

The principal qualities required in a successful engineer are the qualities acquired in the workshop, which are of primary importance, while the qualities acquired as a student, though important, are of secondary importance to the practical. The college trained student, unless he has been in a workshop first, is liable to reverse this order, until he has learnt the lesson by experience.

The student who has been in a works first brings to his college work a knowledge of practical facts which enable him to appreciate to the full the value of his technical lectures. Many of the points raised in the technical lectures are of little meaning or interest to the student who has never previously been in a works.

I believe, generally speaking, that technical teachers prefer the student who has previously had some works experience. He is generally an older student and a more earnest and serious one than his younger colleague who has never been in a works.

II. In favour of the method of entering college direct from school many institutions offer scholarships and bursaries for open competition which boys from secondary schools compete for and more readily obtain, and by means of which they are able to pass directly to the technical college. Many of these scholarship winners prove to be most highly competent and efficient students, and generally head the list of students throughout the whole period of their training.

The student who enters the workshop first finds on returning to the college that he has lost much of the information acquired during his school training, particularly his skill in mathematics, and also the habit of study, and

has to spend much time in making up his lost ground

The youth is generally much more certain of his college training if he takes it before entering the works, than if he postpones the college training till he has been through the works, as there are often many inducements held out to him not to break away from his connection with the works, and he is liable to yield to this temptation, particularly if he has an immediate chance of promotion.

However much a student may desire first to enter works there is the difficulty of getting the works to take him on, especially if it is known that he does not mean to remain more than a year or so at the most in the works. This difficulty of getting into a works for a short period before entering a college is a real one, and such a privilege is only possible in certain districts.

Where both college and works are in the same town in which the student resides, such an arrangement may be possible. When either the college or the works, but only one of them, is in the town where the student resides, it is probably best for him to take that course which enables him to remain under home influences during the earlier years of his training. When the student would have in any case to leave the town in which he resides and to go into lodgings, in order either to enter a works or a college, I should be disposed to recommend that he attended the college first, because being away from home, the work, and the associations and the influence of the college would, I think, be more likely to be helpful to the development of his character than would be the case if he entered himself first as an apprentice in a works.

III. The third method, namely, attendance at the works and college concurrently is one which is approved in the Glasgow district of Scotland, and by various firms. I have had some three years' experience of this system, and I am satisfied that it is a very good one.

Read at the annual meeting of the Association of Technical Institutions.

Shipbuilding Notes.

There was launched from the shipyard of Messrs. Cochrane and Sons, Shipbuilders, Selby, on Saturday, the "Earl Monmouth," a steel screw trawler, the principal dimensions being 128 ft. 4 in. by 22 ft. by 12ft. depth of hold. The vessel has been built to the order of Alec L. Black, Esq., of Grimsby, and will be fitted with triple expansion engines by Messrs. C. D. Holmes and Co., of Hull.

H.M.S. *Cricket*, the first of the new coastal torpedo-boat destroyers built for the Admiralty under the 1905–6 naval programme, was launched from Messrs. White's yard at Cowes last week. The vessel has many important improvements, will burn oil fuel only, and her turbine engines will possess increased power for going astern, making her much more handy than vessels with this means of propulsion usually are. She is to travel at 26 knots.

The London and Glasgow Engineering and Iron Shipbuilding Company, Ltd., launched from their yard at Govan, last week, a steel screw steamer for Messrs. Maclay and McIntyre, Glasgow. The dimensions of the vessel are: 385 ft. by 49 ft. 0 in. by 28 ft. 8 in. moulded, and about 4,220 tons gross, and she is designed to carry 6,800 tons deadweight on 23 ft. 3 in. draft of water. The vessel is built to class 100 A 1 at Lloyd's, three-deck rule, under special survey, and the builders will supply her machinery.

An important launch took place on the 25th inst. from the yard of the Northumberland Shipbuilding Company, Ltd., Howdon-on-Tyne, the vessel being *The [illegible]*, a steamer built to the order of Messrs. Houlder Middleton, and Co., London, for the Reliance Shipping Company, Ltd. She is 372 ft. long by 48 ft. beam by 30 ft. 10 in. deep, and has been built under special survey to the highest class at Lloyd's spar deck rule with extra strengthening for special freeboard. She is fitted with long poop, long bridge, and top-gallant forecastle. The loading and discharging gear includes eight steam winches by Messrs. Clarke, Chapman, and Co., Ltd., Gateshead-on-Tyne, a large number of cargo derricks, and steam windlass by Messrs. Emerson, Walker and Thompson Brothers. The machinery will be supplied by Messrs. Richardsons, Westgarth and Co., Ltd., Sunderland, consisting of engines with cylinders 25 in., 41 in., and 69 in., by 48 in. stroke, three large steel boilers 14 ft. by 10 ft. [illegible] in., 180 lb. working pressure. The steamer will carry about 7,150 tons deadweight and steam about 10 knots speed loaded at sea.

Worm Contact.

By Robert A. Bruce.

Continued from page 1—

In Appendix II [illegible] taking the product [illegible] measure of the effective [illegible] curvature of the surfaces at the point of contact. [illegible] portional to the square root of the product of the radii [illegible]

SOME RESULTS SUMMARISED.

Therefore, to sum up, the area of physical contact [illegible] by the square root of the diameter of the wheel ; or, if [illegible] line of the worm-wheel at the centre of t[illegible] considered, it may be said that the effective area of contact varies as the continued product of the di[illegible] of the worm, the tangent of half the angle subtended by the worm-wheel, and the square root of the diameter [illegible] as the number of teeth in action [illegible] other [illegible] ful in- [illegible]

reasonably be anticipated that the end thrust would be proportional to the effective area, and neglecting comparatively unimportant factors we may ex[illegible] the relation as follows —

$$P = K \cdot \sqrt{D} \cdot d \tan \frac{\theta}{2}$$

= some factor depending on conditions × effective breadth × effective width across the face of the worm-teeth.

where P = safe end pressure in lbs.

d = diameter of worm at pitch line.

D = diameter of worm-wheel pitch line.

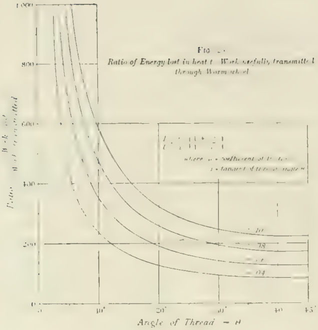
θ = [illegible] by the worm-wheel at the axis of the worm.

K = factor depending upon rubbing velocity, [illegible] nature of the lubricant, etc.

Experience has shown that this relationship is far [illegible] in the factor K imposed by variable conditions. A worm [illegible] the lubricant does [illegible] tact, further heat[illegible] [illegible] quickly.

PROPORTION OF USEFUL WORK.

[illegible]



So that the proportion of lost to useful work is expressed thus:—

$$\frac{L}{U} = \frac{\mu}{a}\left\{\frac{1 + a^2}{1 - a\mu}\right\}$$

A diagram is given, fig. 25 (page 258), showing the values of the fraction $\frac{L}{U}$ for various values of μ and θ. The values to be ascribed to μ are somewhat difficult to arrive at. In experiments by Bach and Roser on a soft steel worm meshing with a bronze worm-wheel lubricated copiously with a heavy cylinder oil μ calculated from the ratio of L to U varied from 0·067 to 0·027 being generally speaking highest at low velocities (50 ft. per minute) or at high velocities (over 1,000 ft. per minute); whilst at medium velocities (270–550 ft. per minute) it was lowest, varying little (0·037 to 0·027) under widely differing loads. In some experiments made by Sellers and Co. on cast-iron surfaces the coefficient was highest at very low velocities (3 ft. per minute) and gradually got less as the velocity increased up to 200 ft. per minute.

In these experiments the value of μ varied but little for varying values of pressure. Values of μ deduced from Bach and Roser's experiments are given in the accompanying diagram, fig. 26 (page 258).

The advantage of employing worms with as large a thread angle as possible, that is to say, with the greatest possible ratio of pitch to diameter, now becomes apparent.

For a given amount of work to be performed by doubling the pitch the velocity is halved and the work wasted in heat is materially reduced. The effect is twofold: the temperature of the lubricant being less its viscosity is sustained, and the velocity being less the value of the load that may safely be borne is increased. Such experiments as have been made to determine the relationship between the pressure and velocity are not altogether concordant, and it remains to establish firmly the laws which govern this sort of friction. The most careful experiments known to the author were those on a soft steel worm-gearing, with a bronze worm-wheel, with oil-bath lubrication, made by C. Bach and Roser, alluded to above. The lubricant was a very thick cylinder-oil, and the experiments were continued till there was no further rise of temperature, the heat lost through radiation balancing the amount generated in friction. The values of K in the appended table have been calculated from the experiments. If the values of P are calculated by means of the values of K here given, it must not be assumed that they are the highest values that could be safely adopted, but they represent the pressures which may be adopted for continuous running with limited rise in temperature. It must be pointed out, however, that they are only reliable if the conditions of the original experiments are carried out. These were as follows: the lubricant used was a viscous cylinder oil and the surfaces soft steel and bronze, the worm dipped into an oil-box whose volume was about three times that of the worm, and the worm-wheel was enclosed. It will readily be seen therefore, that with superior methods of cooling and by the choice of superior working surfaces, very much larger working pressures might be realised, especially if the worm be of hardened steel.

TABLE 2.

Values of K in formula $P = K \sqrt{D} \cdot d \tan \frac{\beta}{2}$ deduced from the experiments of Bach and Roser. The conditions being:—

Material.—Soft steel worm. Bronze worm-wheel.

Lubricant.—Heavy cylinder-oil.

Lubrication.—Worm dipping in oil bath. Size of bath about three times volume of worm with proportionate cooling surface.

Fig. 26. Relation between Coefficient of Friction, Pressure, and Velocity, Deduced from Experiments of Bach and Roser.

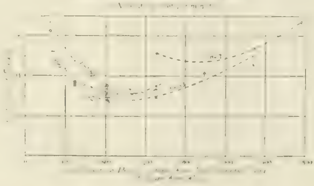
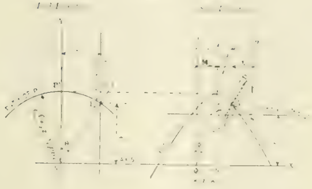


Fig. [illegible]



Values of K.

Rubbing Velocity. Feet per minute.	[illegible] Temperature		
	50° F.	[illegible]	[illegible]
100	111	151	182
200	[illegible]	112	[illegible]
300	[illegible]	[illegible]	121
400	48	77	[illegible]
600	[illegible]	[illegible]	85
800	15	[illegible]	[illegible]
1,000	[illegible]	32	[illegible]
1,200	—	[illegible]	52
1,400	—	18	[illegible]

The experiments of Messrs. [illegible] alluded to above showed that for short periods the value of K for velocities up to 200 ft. per minute might be as high as 320 in the case of cast-iron surfaces lubricated with lard oil. For continuous running, however, much lower values should be taken.

APPENDIX I

Let OX, fig. 27, represent the axis of a screw or worm and OP the generator of one of its acting surfaces, both being in the vertical plane.

The intersection of OP and the axis OX at O is chosen as the origin of coordinates.

The worm surface is generated by the generator simultaneously advancing along and rotating about the axis OX; an advance of l [illegible] corresponding to one complete revolution.

Let a be the [illegible] of the generator along OX when the latter is turned through an angle θ.

Then $a = \frac{l\theta}{2\pi}$ (1)

When the generator [illegible] through an angle θ it moves from the position OP to O_1P_1 in side elevation, fig. 27, or from O_1P_1 to O_1P [illegible] end elevation.

Then it is easily seen from the figure that

$$\sin\theta = [illegible] \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Hence [illegible] (3)

[illegible] (4)

and [illegible] (5)

The expression (5) is the equation of the generated helical surface.

In order to obtain the equation of the curve of intersection of such a surface by a plane parallel to the axis and distant d from it and from the initial position OP of the generator, we have only to put $z = d$ in (5) and we get

[illegible] (6)

Differentiating

[illegible] (7)

Differentiating again

[illegible] (8)

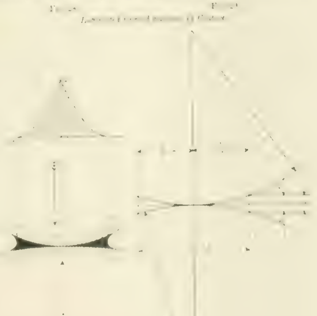
where A, d and B are constants.

The radius of curvature at any point is

[illegible] (9)

Again [illegible] is the co-tangent of the angle included between the axis and the tangent to the curve of section at

Fig. [illegible] Fig. [illegible]



the point whose co-ordinates are xy. Or again, x is the tangent of the angle included between the normal to the curve of section at xy and the pitch line (which is parallel to the axis).

In fig. 27 (page 259) CP_2D is the plane section of the helix and P_2S is the normal at P_2. S is therefore the pitch point, and if RST are fresh axes of co-ordinates, and X and Y the co-ordinates of P_2 referred to them, we have

$$Y = Xx \quad \ldots \quad \ldots \quad (10)$$

which is the equation of the path of contact belonging to the plane section whose equation is (6).

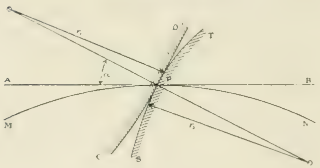
In using (10) we must remember that

$$y = Y + r \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

where r = the pitch radius of the worm. And hence (10) can be expressed in terms of X and Y and constants.

Fig. 30.

Curved Surfaces in Contact



APPENDIX II.

If fig. 28 (page 259) represents a plane section of the curved surfaces of a worm and worm-wheel, with a thin film of oil or grease sustaining the load pressing them together, it is reasonable to suppose that the intensity of pressure will be greatest at c where they are nearest together, and that it will tend to become zero at points a and b, where the surfaces are so separated that the oil-film breaks down. The distribution of pressure may in fact be represented by the curve MQN, ordinates from the base line MN representing intensity of pressure.

The width MN may be taken as representing the "effective breadth" of contact for the section. It is clear that this "effective breadth" varies with the curvature of the surfaces, the nature of the lubricant and the surfaces themselves, and the relative or rubbing velocity. Whilst the effect of the last three of the variables enumerated can be only dealt with experimentally, the effect of curvature alone can be treated mathematically. Thus for constant conditions of lubricant, nature of surfaces and rubbing velocity, there should be some thickness of film t at which the power of sustaining load becomes nil. This thickness t may be considered constant under the conditions laid down.

Let the radii of curvature of the surfaces where their distance apart is least (*i.e.* where the oil-film is infinitely thin) be r_1 and r_2; then, since we are dealing with films of capillary thickness, we may treat the dimensions in this direction as infinitesimals compared with r_1 and r_2.

The following equations may be verified from fig. 29 (page 259).

$$\left(\frac{b}{2}\right)^2 = t_1(2r_1 - t_1) \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$\left(\frac{b}{2}\right)^2 = t_2(2r_2 - t_2) \quad \ldots \quad \ldots \quad (2)$$

Hence since t_1 and t_2 are small compared with r_1 and r_2

$$b^2 = 8r_1t_1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$b^2 = 8r_2t_2 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\text{Hence } t = t_1 \pm t_2 = \frac{b^2}{8}\left(\frac{1}{r_1} \pm \frac{1}{r_2}\right) \quad \ldots \quad (5)$$

$$\text{or} \quad b = \sqrt{t} \times \sqrt{\frac{8r_1r_2}{r_2 \pm r_1}} \quad \ldots \quad (6)$$

The negative sign indicates similar and the + sign indicates dissimilar curvatures.

But as t is supposed constant for the assumed constant conditions of speed, lubrication and surfaces, we may write

$$b = K\sqrt{\frac{r_1r_2}{r_2 \pm r_1}} \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

In this investigation the surfaces are supposed to be actually touching at one point, a condition not quite in accordance with what one might anticipate, but it may reasonably be assumed that the film's thickness at the minimum distance of the surfaces is small compared with its maximum thickness, so that equation (7) may be regarded as approximately true.

APPENDIX III.

The expression given for the effective breadth of contact is capable of considerable simplification when contact takes place at the pitch line.

The theorem upon which this depends is to be found in any work which treats of the curvature of the envelope of a curve carried by a rolling curve and invariably connected with it, and is attributed to Chasles (see p. 355, "Williamson's Differential Calculus," 6th edition).

Let AB, fig. 30, be a straight line (the pitch line of a worm), and CD a curve connected by it and carried by it (a worm tooth section). Let AB roll on the circle MN (the pitch line of the worm-wheel), and in so doing let CD generate the envelope ST (which is therefore the section of the mating worm-wheel tooth). Then, when contact takes place at the pitch line, it

r_1 and r_2 are the radii of curvature of the surface sections in contact at P—

$$\frac{r_1 r_2}{r_1 + r_2} = R \cos a,$$

where R is the radius of MN and therefore the pitch line radius of the worm-wheel, and a is the angle of inclination of the contact path at the pitch line.

Hence at the pitch line [illegible] $\cos a$. This expression for $\frac{r_1 r_2}{r_1 + r_2}$ is a good average value for the contact of any two sections of worm and worm-wheel throughout their contact.

Section on Plane Lettered	l = Distance of Section from Central Plane	Values of $\sqrt{\cos a}$: Pitch = 2 ins. See Fig. 20A of Text	Pitch = 6 ins. See Fig. 20 of Text	Pitch = 12 ins. Not Illustrated.	Pitch = 18 ins. See Fig. 19 of Text.
	Ins.				
DD	1·[illegible]	0·44[illegible]	[illegible]	No Contact.	No Contact
CC	1·[illegible]	0·454	[illegible]	[illegible]	No Contact
BB	[illegible]	[illegible]	0·455	[illegible]	0·529
AA	[illegible]	[illegible]	[illegible]	0·508	[illegible]
EE	−[illegible]	[illegible]	0·550	[illegible]	0·621
FF	−1·[illegible]	0·522	0·573	[illegible]	[illegible]
GG	−[illegible]	0·523	[illegible]	[illegible]	0·725
Average Value		[illegible]	[illegible]	0·43	0·41

APPENDIX IV.

It has been already shown that

$$[illegible] \sqrt{R \cos a}$$

Calculations made show that the average value for $\sqrt{\cos a}$ does not greatly alter for very considerable variations of the ratio of worm-thread angle. The pitch radius of the worm is throughout 6 in.

Refer to figs. 19, 20, and 20A (see last issue).

APPENDIX V.

In the case of an ordinary worm with straight-sided teeth whose sides are inclined to each other at an angle of 29° the average number of teeth in contact from the moment when contact takes place till the pitch line is reached can be found from the equation—

$$N = [illegible]$$

Where n = ratio of worm wheel radius to pitch of the teeth.

If n = 2 the wheel has 12 teeth and N = 0·75

[illegible]

As the number of teeth engaged between the pitch line and the point where contact ceases is unaffected by n, the total number of contact surfaces in action at any given gear is but slightly affected by the number of teeth in the wheel.

* Abstract of paper [illegible] the Institution of Mechanical Engineers.

Motor Notes.

The Motor Show at the Crystal Palace is of modest proportions in comparison with the great [illegible] Olympia [illegible] [illegible] of fairly well-known firms are exhibiting at Sydenham, [illegible] following [illegible]

[illegible] commercial vehicles and [illegible] Motor and [illegible] Exhibition [illegible] the week [illegible] Waverley Market. An excellent [illegible] made by the [illegible] exhibitors being [illegible]

THORNYCROFT MOTORS

[illegible]

2-CYLINDER THORNYCROFT MOTOR TRACTOR.

being the Thornycroft standard "make and break" type, while the Eisemann system is used to provide the high tension current.

The drive is transmitted to the back axle through a friction disc clutch running in oil and a 4-speed gear box. The whole of the gears are enclosed in a dust-proof and oil-retaining case, the lowest portion being 18 ins. from the ground. Sufficient space is provided to carry water, lubricating oil, and fuel for a run of 100 miles without replenishing. The guaranteed capability of this vehicle was to pull a gross load of 5 tons under any practical conditions.

The official tests, which were satisfactorily carried out, were as follows:

(1) A brake test of the engine when in position on the vehicle using its own radiator, fuel tanks, &c. (2) An official road test pulling a gross load of 14 tons on an incline of 1 in 12. (3) An official test over soft ground pulling a gross load of [illegible] tons. During this test the tractor was made to haul its load while running forwards and backwards, and finally to pull its load out of soft ground with the winding gear.

The smaller tractor is built to a standard pattern, but with several modifications to meet the requirements of the War Office, the most important of which is an arrangement to drive a field searchlight when stationary.

The official trials were:—A six-hours' trial of the engine driving its dynamo at full load. The dynamo is intended to provide current for a field searchlight, and its output was shown to be quite sufficient for this purpose. A road trial of 200 miles, which was performed quite satisfactorily under official supervision.

This tractor is adapted to haul the field searchlight with the cable on a drum.

MOTOR ROADS FOR SIAM.

The first number of Siam Engineering deals with a problem under present and lively discussion in this country, the construction of motor roads. No fewer than six papers, contributed to the initial number of the journal, discuss the formation of a motor road to connect Bangkok with Penang. The main object in view is quicker postal communication with Europe; subsidiary purposes are rapid passenger traffic, opening

up of business in the intervening country, lastly pleasure and sport. The engineering feat of constructing 700 miles of suitable road is obviously no light one. But the various authorities, while varying considerably in their estimates of cost, are fairly unanimous in the opinion that no great natural obstacles are present, that proper road-making material exists along the route, and that the labour conditions are satisfactory. The suggestion made by the president of the Engineering Society, is that, if the Siamese Government would construct and maintain the track, the European residents in Bangkok should bear the expense of the mail service for the benefit of the Government and the rest of the community. It is proposed that this expenditure should be met by a voluntary tax of 1 or 2 per cent. on personal income, or by voluntary subscriptions from individuals and business firms.

GOLD MINING AND MOTOR LORRIES.

It is stated that the Honduras Rosario Mining Company of Lorenzo have decided to place in immediate service several petrol lorries for hauling gold and silver over a route in Central America that is now covered by hundreds of pack mules. The total distance between the mines of Tegucigalpa, the capital of Honduras, and San Lorenzo is ninety miles, and the vehicles will load both ways—outwards with concentrates, and home with miscellaneous goods and stores for the mines. The gold and silver concentrates will be shipped to New York and smelted for the refineries. Each vehicle is expected to carry the load of twelve mules, and to perform the journey six times as quickly, therefore displacing seventy-two mules. A mule load is 250 lb. avoirdupois, and is contained in two sacks slung across its back. The ninety miles' journey is at present not performed under six days by a mule train, and often occupies more time when weather conditions are adverse. The petrol vehicles will run out and back, 180 miles, in two days. This quick service is made possible by the fact that the Government of Honduras, being keenly alive to the possibilities of such motor services in advancing the prosperity of the country, has spent more than a million dollars on the route, and there are no gradients steeper than one in ten. The cost of petrol in Honduras is stated to be only tenpence per gallon, and the cost otherwise of operating the motor lorries will be carefully recorded to ascertain just how much is saved in comparison with the primitive pack mule trains.

4-CYLINDER 40 H.P. MOTOR TRACTOR FOR THE WAR OFFICE.

Howard Lectures.

THE second Howard lecture on the subject of High Speed Electric Machines was delivered at the Society of Arts, on January 25th, by Professor Silvanus P. Thompson. Dr. Thompson said that in applying the principles laid down in his first lecture to the general question of the driving of continuous-current generators by engines of high speed, and particularly by steam turbines, one came at once upon the crux of the whole question. He referred to the problem of commuting the current in the armature and collecting it satisfactorily at these high speeds. The problem was as old as the dynamo itself.

In all so-called continuous current generators (excepting those of the rare species called homopolar or unipolar), the current within the armature was necessarily alternating. But these internal alternating currents differed from those of ordinary alternators in respect of their wave form.

The current in any one armature passed in fact from the value + C, to the value − C, during a brief interval of transition lasting usually only from one-twentieth to one-tenth of the half-period or, lasting from 1-800th to 1-200th of a second.

Each armature conductor formed part of a loop or coil of the armature winding. In the simplest case it constituted one side of a simple loop or element connected at one end to a segment of the commutator, and at the other end to an adjacent segment each of these "sides" of the loop being embedded in a slot of the armature core.

It was not possible when a current was flowing around any loop, to stop that current instantaneously; nor having stopped the current was it possible to start it again instantaneously in the reversed direction around the loop. The dying away and the growth of a current both required time. This was because of the interlinkage of the current itself with the magnetic lines of its own creation in the space surrounding itself. There had been many attempts made to find simple approximate rules for the amount of interlinkage of a current with its own magnetic lines.

A conductor of round or square section lying in air was estimated to create in the space surrounding itself four magnetic lines per ampere for each inch length of the conductor. This was a coarse approximation only. For if the conductor was very small, say a wire [illegible] of an inch in diameter, and the ampere passed through it, that ampere could set up a much more intense field around the wire than if it were flowing in a wire ¼ in. in diameter distributed through one hundred times the cross-section. Or again if a current was flowing in a round wire of ¼ in. diameter the field which it set up around itself would be denser than that which the same current would set up if flowing in a flat ribbon of equal section say 1 in. wide and 1-16th in. thick.

INTERLINKAGE OF MAGNETIC LINES.

In large continuous current dynamos the conductors were nearly always flat strips, not round wires and as they usually had to carry from 100 to 150 amperes (at full load), and had a current density of about 2,000 amperes per sq. in. the strip would usually have a section of 1-20th to 1-12th sq. in. The magnetic field surrounding such a strip, in air, might be taken to produce, with a current of 100 amperes about 200 lines per inch length of strip, or about 2 lines per ampere per inch.

If the strip was embedded in a slot between iron teeth the amount of throttling magnetic flux which each ampere would set up around each inch length so embedded would be considerably greater than is the case with non-embedded strip. According to the best authorities, a strip embedded in a narrow slot open at the top might be taken to set up 10 lines per ampere per inch.

Considering the total interlinkage of magnetic lines that would occur in a concrete case, he would take the case of a generator in which there were 100 amperes in each conductor and that each loop of the armature consisted of 18 in. of embedded length, and of 48 in. of free length. Then with two layers according to the foregoing data the total surrounding magnetic flux would be $(18 \times 10 \times 2) + (48 \times 2) = 360 + 96 = 456$ lines per ampere or 45,600 in all. Or, taking the embedded and free parts together the linkage would be 456 lines per ampere.

Suppose that the time allowed for commutation was only 1-500th of a second, and that (though the assumption could never be quite accurately fulfilled) the current could change from + 100 to − 100 amperes at a perfectly uniform rate during that time, that was, could alter by 200 amperes in 1-500th of a second. This was at the rate of 100,000 amperes per second.

COMMUTATION PROBLEMS.

Having thus stated the main fact that the reversal of current was a process requiring time, it was obvious that into the commutation-problem in its very simple form, apart from all theories of self-induction, there entered considerations as to the surface speed of the commutator, the breadth subtended at the surface by each commutator segment, and the breadth of the brush. For the time from beginning to end of the commutation, would be directly proportional to the sum of the peripheral length of the brush arc of contact and the thickness of the mica insulation between segments, and inversely proportional to the peripheral speed. Thus if one had a brush arc of 0.75 in., a thickness of 0.030 for the mica, and a surface speed of 1,000 in. per second, the duration will be 0.0007[illegible] sec.

Brushes were either of metal—that was copper gauze or brass wires—or of carbon, and the breadth of the contact arc of the former was always much less than that of the latter. Carbon brushes by the mere circumstance of their greater breadth gave a longer time for reversal. On the other hand, since during the reversal period the coil or loop was short-circuited the use of an unduly broad brush might lead to a wasteful heating; for during this period the coil might under certain circumstances be the seat of a vastly increased parasitic current.

Since the introduction of carbon brushes some fourteen years ago engineers had had much less trouble with commutation than before. For with metal brushes not only was it necessary to have a much more precise setting of the brush at a particular position than was found to be required with carbon brushes, but the position of sparklessness varied with the load, requiring continual adjustment. It was scarcely too much to say that with the variable loads that occurred in tramway work the use of carbon brushes made all the difference between failure and success. And in recent years engineers had learned what a vital part in the problem of satisfactory commutation was played by the resistance of the contact film between the brush and the surface of the commutator. Down till about [illegible] engineers still clung to the old theory of Hopkinson of the reversing field, although for some time it had been evident in view of the fact that commutation could be obtained sparklessly on motors without giving the brushes a lead either way, that this theory was wholly inadequate. Commutation might be conveniently considered under two heads: natural commutation and forced commutation. The former depended on the natural reversal of the current as the result of the resistances of the brush-contact films; the latter on the introduction, into the coil, during commutation, of an induced voltage (due to movement in a magnetic field) to force reversal to occur. In the majority of generators both actions were made use of jointly; but it would be convenient to consider them separately. Natural commutation was brought about by the operation of the film resistances through which the current must pass, and which by varying approximately inversely as the areas of contact, governed the admission or exclusion of the current through particular routes. There was a close analogy between this operation and that of the slide-valve of a steam engine.

The term "film" was used not to assert that there was anything in the nature of a layer of air or other material between the surface of the brush and the surface of the commutator, but because it was difficult to conceive of any mere surface as having a resistance. That which happened between the two surfaces was doubtless a kinetic phenomenon of a complicated kind, the layer being the seat of molecular movements, electric discharges and convexion currents, transferences of ions and electrons such as occurred in the contact layers of microphones and coherers.

For the formulation of any complete theory of commutation no less than for future guidance in practice it was important to obtain a clear view of the facts that had been observed as to the resistances of contact films under different conditions. Professor Arnold, who had discussed in utmost detail the mathematical theory of commutation, has given as a criterion as to the goodness of commutation the value of the final potential difference which appeared between the toe of the brush and the retreating edge of the commutator segment.

CARBON BRUSHES AT HIGH SPEEDS.

A good many manufacturers had been experimenting with carbon brushes, in some instances in conjunction with copper brushes, and the problem to be solved was [illegible] to be employed at high speeds. In this connection he would refer to the carbon brushes of the Morgan Crucible Company.

Besides the possibility of perfecting commutation [illegible] there was the possibility of having [illegible] of the Acyclic type. It was a great thing [illegible] current [illegible] copper brushes [illegible] feet per minute, and it was [illegible] than one type of [illegible] and one of which he had particularly [illegible]. Although not very [illegible] of these machines it was [illegible] and on that [illegible] ties.

Contractors' News.

We shall be pleased to insert under this column, free of charge, particulars of open contracts

CONTRACTS OPEN.

Last Day.

London.—For the following plant and materials for the Battersea Borough Council: (1) one set either 750-850-k.w. or 1,000-k.w. direct-current 400 to 550 volts steam generator, piping, and ejector condenser; (2) arc lamp columns; (3) arc lamps; (4) arc lamp globes. The Chief Engineer, Electricity Department, Lombard Road, Battersea ... ... Feb. 5

Wolverhampton. — The Corporation invite tenders for the manufacture, delivery, and erection of an aerial ropeway, approximately 1, 300 yards in length, and other works incidental thereto. Mr. E. A. B. Woodward, waterworks engineer, Town Hall, Wolverhampton. ... Feb. 5

Manchester.—Supply, delivery, and erection of three new Lancashire boilers, etc., and the removal and re-erection of two existing boilers, at their Rochdale-road station, for the Manchester Corporation Gas Committee. Mr. C. Nickson, superintendent, gas department, Town Hall ... Feb. 5

Sparkhill (Birmingham). — Provision and construction of the following approximate lengths of surface-water sewers, for the Yardley Rural District Council—viz.: 992 yds. of 24 in., 130 yds. of 21-in., 260 yds. of 18-in., 231 yds. of 15-in., 103 yds. of 12-in., and 480 yds. of 9-in. pipe sewer; also of the following approximate lengths of foul-water sewers: 480 yds. of 15-in. and 233 yds. of 12-in. pipe sewer—together with manholes, lampholes, flushing shafts, and other works appertaining thereto. Mr. Arthur W. Smith, Council House, Sparkhill ... ... Feb. 7

Poole.—The following works in connection with the Parkstone tramway extension with the Parkstone tramway extension, for the Poole Town Council (Section No. 1) permanent-way construction, etc. (Parkstone extension); (2) permanent-way construction, etc. (new passing places, etc.); (3) overhead equipment, etc.; (4) feeder cables, etc. Engineer, Mr. F. W. Lacey, Municipal Offices, Bournemouth Feb. 7

Belfast.—Supply of stores during ensuing year commencing from March 1st and terminating on Feb. 28th, 1907, for the Midland Railway Company Northern Counties Committee (Ireland). Mr. Ellis, stores superintendent, York Road Station, Belfast Feb. [illegible]

Last Day.

Leicester.—Supply and erection, on foundations provided, of three Lancashire boilers, 22 ft. by 7 ft., at their Aylestone Road Works, for the Gas and Electric Lighting Committee. Mr. Alfred Colson, M.Inst.C.E., engineer and manager, Millstone Lane, Leicester ... . Feb. 10

Hull.—The following for the Town Council (1) supply of air-space telephone cable; and (2) extension to existing multiple switchboard. Mr. A. R. Bennett, Queen Anne's-chambers, Dean Farrar Street, Westminster, London, S.W. ... Feb. 12

Glasgow.—Electrical cable and conductor installation for Clydebank Dock, for the Trustees of the Clyde Navigation Mr. Geo. H. Baxter, mechanical engineer, 16, Robertson Street, Glasgow ... ... Feb. 12

Porthcawl (Wales.) — Construction of an impounding reservoir, with concrete dam, to contain about $1\frac{1}{2}$ million gallons of water, together with about $8\frac{1}{2}$ miles of cast-iron mains, laid complete, of 5 in., 4 in., and 3 in. diameter respectively, and other minor works, for the Porthcawl Urban District Council, by Messrs. John Taylor, Sons, and Santo Crimp, 27, Great George Street, Westminster, S.W. ... Feb. 12

Pontypridd. — Supply, delivery, and erection of one 300-k.w. steam dynamo, for the Pontypridd Urban District Council. Mr. J. Colenso Jones, clerk, District Council Offices, Pontypridd ... Feb. 13

Newport (Mon.)—Provision of a lift at their workhouse infirmary, Stow-hill, Newport, for the Guardians. Mr. I. Thomas, clerk, Union Offices, Queen's-hill, Newport, Mon. ... . Feb. 15

Cardiff.—Supply of cooling-towers, electrically-driven pumps, pipework, etc., for their Roath power-station. Mr. Arthur Ellis, city electrical engineer and manager, Central offices, The Hayes, Cardiff ... Feb. 15

London, S.W.—Manufacture, supply, and erection of three gas-engines, each having three inverted single-acting cylinders over three cranks, and each capable of developing 350 b.h.p. at a speed of 100 r.p.m., for the London County Council. Mr. Maurice Fitzmaurice, C.M.G., County Hall, Spring Gardens, S.W. ... ... Feb. 20

Arkley (Herts). Covered service reservoir capable of holding about two million gallons, to be constructed on the company's land at Arkley, Hertfordshire, for the Barnet District Gas and Water Company. Mr. T. H. Martin, A.M.Inst. C.E., engineer and manager, Station Road, New Barnet ... ... Feb. 27

Last Day.

Sunderland.—Supply of (1) one boiler feed pump; (2) one wooden cooling tower; (3) one surface condenser with motor-driven pumps; (4) coal bunkers, gantry, and other steelwork. Mr. J. F. C. Snell, M.Inst.C.E., Town Hall, Sunderland ... ... Mar. 2

Dover.—Supply and erection of 30 kilowatts combined-steam generator set for traction purposes. The engine to be of the high-speed vertical compound enclosed type with forced lubrication. Mr. L. W. Woodman, Park Street, Dover .. .. Feb. [illegible]

Sheffield.—Driving and lining of the Rivelin tunnel for the Sheffield Corporation Water Department. Resident Engineer's Office, [illegible] Bower, Bamford, near Sheffield .. . —

Stockport.—Supply and erection of inclined retort benches, together with 16 furnaces and settings complete with all ironwork, coal hoppers, coal elevating and conveying plant and hot coke conveying and storing plant for the Gas Committee. Mr. St. Meunier, Portwood Gasworks, Stockport. .. . Feb. 14

Blackburn.—The Electricity and Tramways Committee invites tenders for the supply of the following stores for the year ending March 31st, 1907. (1) General stores; (2) [illegible] copper, brass castings, bolts, [illegible] etc.; (3) brushes, [illegible] etc.; (4) paints, varnishes, etc.; (5) timber; (6) glass; (7) insulating material; (8) tools; (9) oils, greases, etc.; (10) incandescent lamps; (11) meters, alternating and continuous current; (12) wrought-iron pipes, [illegible] cast-iron pipes, etc.; (14) rubber and [illegible] house service fuse boxes, [illegible]; (16) motors; (17) [illegible] switches; (18) arc lamp [illegible]; (19) screwed tube for [illegible]; [illegible] covered paper [illegible]. Borough Electrical Engineer [illegible] Feb. 12

COMING CONTRACTS.

Liverpool.—The new scheme involves the construction of a half tide dock, or two branch docks—capable of taking the largest liners—and the enclosure of a new area of foreshore on the north side of Liverpool, by an extension of the existing dock wall towards Waterloo.

Birmingham.—An inquiry has just been held relative to the application of the Corporation for power to borrow £132,[illegible] for the purposes of their electric supply undertaking.

Brandon.—It is proposed to erect a dust destructor at a cost of £10,000.

Carmarthenshire.—The County Council have agreed to provide the sum of £40,000 for promoting a light railway in the Lampeter and Llandovery district.

Uttoxeter.—A Local Government Board inquiry has been held into the scheme for augmenting the water supply to the town of Uttoxeter. The cost will be £13,000.

Warrington.—The Electricity and Tramways Committee are making an application to borrow £10,000 to cover the cost of extensions to the electric cables.

Blackpool.—An inquiry has been held in connection with the application of the Corporation for sanction to borrow £4,000 for electric supply purposes.

Uckfield.—The application of the Council for sanction to a loan for the purposes of sewerage and sewerage disposal for Crowborough, has been granted to the extent of £37,100.

CONTRACTS CLOSED.

London.—The Brush Electrical Engineering Company have received the following contract: Six tramcar top deck covers for the Aberdeen Corporation.

Birmingham.—Messrs. Thomas Piggott and Co., makers of pipes, tanks and steel structures, have recently secured orders for the following—20 pressed steel standard tanks for Buenos Ayres; riveted steel chimney, 6 ft. diameter, 125 ft. high; pithead frame for South Wales; pressed culvert pipes, 36 in. diameter, for South Africa; riveted rectangular flues for Newcastle Power Station.

Manchester.—Messrs. Beyer, Peacock and Co., Ltd., of the Gorton Foundry, Manchester, have lately secured contracts for supplying 30 six-wheeled coupled bogie compound freight locomotives for the Buenos Ayres Great Southern Railway and for six six-wheeled coupled bogie freight locomotives, fitted with cylinders 19 in. in diameter by 26 in. stroke, and boilers 5 ft. 6 in. in diameter, with a working pressure of 200 lb. per square inch, for the Argentine Great Western Railway.

Shoreditch.—The Electricity Department of the Shoreditch Borough Council has placed an order with the Stirling Boiler Company which stipulates for the supply by Messrs. Ed. Bennis and Co., Ltd., Little Hulton, Bolton, of eight patent chain grate stokers, Bennis-Miller Bennett type, fitted with the "Bennis" patent light load damper, the necessary shafting, gearing and accessories. The stokers are to be used in connection with both Stirling and Babcock and Wilcox water-tube boilers.

London.—The London County Council have accepted the following tender:—For supply of steel rails for the reconstruction of first section of the northern tramways lines, Messrs. Steel, Peech, and Tozer, Sheffield, at £10,055.

Liverpool.—Messrs. Francis Morton and Co., Ltd., constructional engineers, Garston, Liverpool, have received an order for 47 bridges of about 60 ft. span for the East Indian Railway to the requirements of Messrs. Rendel and Robertson, consulting engineers. This follows an order for 179 bridges of 40 ft. span for the North-Western Railway of India, which they are just completing.

Glasgow.—An order has been placed by the Corporation of Glasgow with Messrs. Babcock and Wilcox, of Renfrew, for ten of their boilers, to be employed in the extension of the electricity supply at the generating stations of St. Andrew's Cross and Port Dundas.

Glasgow and South - Western Railway.—The Glasgow and South-Western Railway Company have accepted the offer of Messrs. Symington and Sons, contractors, Coatbridge, to carry out alterations. These include a new station at Elderslie, double island platforms to allow of passing the traffic expeditiously, and an additional bridge over the turnpike road.

East Hampstead.—The Town Council of East Hampstead have accepted the tender of Messrs. Allen, Son and Co. for a combination of direct steam-driven and electric-driven pumping plant.

Admiralty.—The British Boiler Fluid and Engineers' Stores Company, Ltd., of 10, Church Row, Limehouse, London, E., have been awarded the contract for supplying the British Admiralty with their "Dejecoline" boiler fluid for the current year.

Natal.—The Fulham Steelworks Company, Ltd., of London, have recently received an important contract from the Natal Government in connection with the new harbour works at Durban. The contract includes the manufacture and erection of extensive plant for the handling and shipment of coal raised in the mines, and comprises machinery of the most modern type on a large scale.

Heckmondwike.—The Urban District Council have accepted the tender of the Paterson Engineering Company for the supply of a water purification plant for the electricity works.

Johannesburg.—The Rand Water Board has accepted the tender of Messrs. C. C. George and Company for electrical plant, amounting to £24,000.

Poplar.—The Guardians have accepted the tender of W. J. Fryer and Co. to carry out electrical works at the new schools at Hutton for £8,328.

Metropolitan Asylums Board.—The Board have decided to accept, subject to the sanction of the Local Government Board, the estimates of Babcock and Wilcox to provide and fix three of their multitubular boilers, with settings and mechanical stokers, at the South-Eastern Hospital, at £2,259.

Croydon.—The London Electric Firm, Croydon, have received an order from Foot and Milne, Ltd., of 66, Victoria Street, S.W., for about 200 complete sets of their "One Working Part" arc lamp lowering gear for Malta Dockyard, the consulting engineers being Messrs. Preece and Cardew.

Leyton (Essex).—The Urban District Council have accepted the tender for the construction of nine miles of double tramway track and material of Mr. W. Manders, Leyton, at £127,485.

APPOINTMENTS VACANT.

Singapore.—The Municipal Commissioners of the town of Singapore require, as soon as possible, an assistant engineer between 23 and 35 years of age. Salary will be £350 for the first, £370 for the second, and £420 for the third year, paid monthly. Mr. C. C. Lindsay, M.Inst.C.E., 180, Hope Street, Glasgow ... ... Feb. 6

Auckland, New Zealand.—Applications are invited for the appointment of City Engineer to the City of Auckland. High Commissioner for New Zealand, Westminster Chambers, 13, Victoria Street, London, S.W. ... ... Feb. 8

East London.—A professor of physics is required at the East London College in succession to Dr. Lehfeldt. Salary £400 per annum .. ... Feb. 8

Newtownbarry (Ireland).—Construction of a water supply in the town of Newtownbarry, for the Enniscorthy Rural District Council. Mr. Owen Connolly, clerk, Board-room, Enniscorthy Union ... ... Feb. 8

APPOINTMENTS FILLED.

Gloucester.—The Town Council has been recommended by the Electricity Committee to appoint Mr. G. R. White as electrical engineer.

Umtali.—Mr. A. D. Crowther, of the Midland Railway Electrical Department, is leaving Derby to take up an appointment at Umtali, South Africa.

Liverpool.—The Liverpool Electric Power and Lighting Committee recommend the appointment of Mr. Alfred George Smith as gas inspector and superintendent of street lighting, at a salary of £400 a year.

Leeds.—Mr. E. P. Martin, formerly engineer to the unhealthy areas department of the Leeds Corporation, has been appointed deputy city engineer of Leeds, at a salary of £350 per annum.

City and South London Railway.—The Right Hon. C. B. Stuart-Wortley, K.C., M.P., has been appointed chairman of the City and South London Railway in succession to the late Mr. Charles Grey Mott. He is already a director of the Great Central Railway.

Grangemouth.—The Town Council has decided to retain Mr. H. B. Maxwell, Burgh Electrical Engineer of Partick, to renort on the following questions:—(1) The utilisation of water power three miles from the town; (2) the installation of a station in the town; (3) the erection of a destructor; (4) taking a supply in bulk from the Scottish Central Electric Power Company; (5) any combination of the above; (6) or transferring the order to the Scottish Central or other company, with option of purchase.

Share List of Engineering, Electrical, Iron and Steel, and other Companies.

The following is a comprehensive list of Companies in the industries covered by "Page's Weekly," in which shares business is being currently transacted. Additions will be made from time to time as occasion requires. We desire it to be understood that while our Share List will generally be found correct, we do not hold ourselves responsible for any loss or inconvenience that may arise from possible inaccuracies.

STOCK EXCHANGE SETTLING DAYS.—Settling days on the Stock Exchange are as follows:—
Consols: March 1st. General Settlements: Feb. 8th, 22nd; March 9th. Bank Rate, September 28th, 1905, 4 per cent.

I.—ENGINEERING, IRON, AND STEEL COMPANIES.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
11,370	5	5%	Alldays & Onions Pneumatic Engineering, Ltd.	3	2[illegible] — 3
10,000	5	3/-	Do. Cum. Pref. 6 per cent. ..	5	4¾ — 5
3,210,000	1	1/-	Armstrong (Sir W. G.), Whitworth and Co., Ltd.	1	3[illegible] — 3[illegible]
76,370	5	2/-	Do. 4% Cum. Pref. ..	5	5[illegible] — 5[illegible]
1,500,000	100	4%	Do. 4% 1st Mort. Dbs. Rd.	100	101 — 105
£100,000	100	4½%	Aveling and Porter, Ltd., 4½% Reg. Mt. Debs. Red.	100	94 — 97
530,000	1	1/7½	Babcock and Wilcox, Ltd., Ord. ..	1	3¾ — 4
100,000	1	7½d.	Do. 6% Cum. Pref.	1	1[illegible] — 1[illegible]
20,000	5	3/-	Baker (Joseph) and Sons, Ltd. 6% Cum. Pref.	5	[illegible] — 5¼
250,000	1	6⅝d.	Baldwins, Ltd., 5½% Cum. Pref. ..	1	1[illegible] — 1[illegible]
£250,000	Stk	4½%	Do. 1st Mt. 4½% Deb. Stk. Red.	100	101 — 103
150,000	4½	[illegible]	Barrow Hematite Steel Co., Ld., O.	4½	[illegible] — [illegible]
50,000	4½	3	Do. [illegible] Cum. 2nd Pref.	4½	[illegible] — [illegible]
33,334	5	2/6	Bayliss, Jones and Bayliss, Ltd., 5% Cum. Pref. Shares	5	4¾ — 5¼
£500,000	100	4½	Beardmore (Wm.) & Co., Ltd. 4½ 1st Mt. Debs., Red., Scrip 50 pd.	—	104 — 106
50,000	10	6/-	Bell Brothers, Ltd., 6% Cum. Pref.	10	12½ — 13
£366,600	Stk	4%	Do. 4% Deb. Stock, Red.	100	99 — 101
200,000	1	1/-	Beyer, Peacock and Co., Ltd., Ord.	1	[illegible]
300,000	1	6½d.	Do. 5½% Cum. Pref.	1	[illegible]
£300,000	Stk	4½%	Do. 4½ Red. Deb. Stock	100	91 — 94
1,629,760	1	6d.	Bolckow, Vaughan and Co., Ltd., O. Nos. 1-1,629,760	1	1½ — 1[illegible]
1,360,900	1	3½d.	Do. Nos. 1,6[illegible]0,101-2,500,000	12/-	[illegible]
1,160,000	1	4½d.	Brown (John) and Co., Lim., Ord., Nos. 1-1,160,000	15/-	1½ — 1[illegible]
590,000	1	6d.	Do. Ord., Nos. 1,160,001-1,750,000	1	1½ — 2
71,000	10	5/-	Do. [illegible] Cum. Pref.	10	11¾ — 12¼
154,500	5	2/6	Cammell, Laird & Co., Ltd., Ord. ..	5	9¾ — 10¼
232,500	5	2/6	Do. 5% Cum. Pref. ..	5	[illegible] — 5[illegible]
450,000	1	1/2½	Clayton & Shuttleworth, Ltd., Ord.	1	[illegible] — 1[illegible]
70,000	5	2/6	Do. [illegible] Cum. Pref.	5	5[illegible] — [illegible]
£250,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	99 — 101
100,000	10	80/-	Consett Iron Co., Ltd., Ord. ..	7½	36½ — 37½
57,031	10	10/-	Crossley Bros., Ltd., Ord. 40310-97370	10	[illegible] — 17[illegible]
40,339	10	5%	Do. 5% Cum. Pref. ..	10	11 — 11[illegible]
75,000	1	2/6	Delta Metal, Ltd. Shares ..	1	2 — 2¼
1,25[illegible]	1	3½d.	Dorman, Long & Co., Ltd.	1	[illegible]
£400,000	Stk	4%	Do. 4% 1st Mort. Perp. Deb. Stk	100	[illegible] — 96
200,000	5	3/-	Dunderland Iron Ore Co., Ltd., 6% Cum. Pref. and Participating	5	3¾ — 4
250,000	1	9¼d.	Dunlop (James) & Co., Ltd., Ord...	1	[illegible]
300,000	1	7½d.	Do. [illegible] Cum. Pref.	1	[illegible]
4,721	13	13	Ebbw Vale Steel, Iron & Coal Co., Ltd.	13	11 — 1[illegible]
69,754	13	10/-	Do. [illegible]	10	[illegible]
20,250	10	8/-	Elliott's Metal, Ltd. ..	8	[illegible]
5,000	10	5%	Do. Cum. Pref. ..	10	8½ — 9
186,748	Stk	4%	Do. Deb. 4%	100	[illegible]
25,000	10	6/-	Fairfield Shipbuilding & Engineering Co., Ltd., 6% Cum. Pref. ..	10	11¾ — 1[illegible]
£250,000	Stk	4½	Do. 4½% Mort. Deb. Stk. Red.	100	100 — 103
126,000	3	2/4½	Fraser & Chalmers, Ltd., Ord.	3	[illegible]
21,000	3	1/6	Do. 7½%, Cum. Pref.	3	[illegible]
10,000	10	5%	Galloways, Ltd. [illegible] Cum. Pref. [illegible] ..	10	7[illegible] — 7[illegible]*
£150,000	Stk	4%	Do. 4% 1st Mort. Deb. Red.	100	[illegible] — 87*
16,800	10	16/-	Greenwood & Batley, Ltd., Ord.	10	6½ — 7
9,600	10	7%	Do. 7% Cum. Pref. ..	10	10[illegible] — 11¼
960,000	1	1/-	Guest, Keen & Nettlefolds, Ltd. Ord.	1	2¼ — 2[illegible]
344,000	5	2/6	Do. [illegible] Cum. Pref.	5	[illegible]
£1,850,500	Stk	4%	Do. 4% Irred. Mort. Deb. Stk	100	[illegible] — 10[illegible]
13,000	5	2/6	Gwynnes, Ltd., [illegible] Cum. Pref.	5	2[illegible] — [illegible]
270,000	1	1/-	Hadfield's Steel Foundry Co., Ltd., Ord.	1	[illegible] — 1[illegible]
20,000	10	4/6	Do. 4½% Cum. Pref. ..	10	10[illegible] — 11
30,000	5	3/-	Hall (J. & E.), Ltd. 6% Cum. Pref. ..	5	[illegible]*
47,500	10	7½%	Hawthorn, Leslie & Co., Ltd. Ord.	10	[illegible] — 9
28,001	5	7/-	Head, Wrightson & Co., Ltd.	5	[illegible]
[illegible]	1	6d.	[illegible] Ltd., Ord.	1	[illegible]*
18,[illegible]	5	3/-	Do. [illegible] Cum. Pref.	[illegible]	[illegible]
£100,000	Stk	6%	Hornsby (R.) & Sons, Ltd., Ord. 6% Cum. Pref.	100	10[illegible] — 10[illegible]

ENGINEERING, IRON, AND STEEL COMPANIES.—Contd.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
750,000	1	6d.	Howard & Bullough, Ltd., Ord. ..	1	1½ — 1[illegible]
2[illegible],000	10	6/-	Do. 6% Pref. Non-Cum.	10	12¼ — 12¾
£250,000	Stk	4	Do. 4% Deb. Stk., Red. after 1905	100	96 — 9[illegible]
37,500	10	20	Kynoch, Ltd.	10	1[illegible] — 1[illegible]
49,537	10	5%	Do. Cum. Pref. 5% ..	10	10½ — 10[illegible]
300,000	1	4½d.	Lambert Bros., Ltd., Ord.	1	[illegible]
50,000	5	2/9	Do. 7½ Cum. Pref. ..	5	4 — 4[illegible]
40,000	3	2/1½	Leeds Forge Co., 7% Cum. Pref.	3	4 — 4¼
200,000	1	7½d.	Lysaght (John), Ltd., 6% Cum. Pf.	1	1[illegible] — 1¼
£300,000	Stk	4½%	Do. 4½ 1st Mt. Deb. Stk., Red.	100	109 — 111
40,000	10	5/-	Mather & Platt, Ld., 5% Cum. Pref.	10	11[illegible] — 12[illegible]
210,000	1	6⅝d.	Measures Bros., Ltd., Ord. ..	1	1 — 1[illegible]
75,000	1	6⅝d.	Do. 5½ Cum. Pref. ..	1	1 — 1⅛
£75,000	Stk	4½	Do. 4½ 1st Mt. Db. Stk., Red.	100	[illegible] — 10[illegible]
21,943	5	2/6	Muntz Metal Ltd.	5	4[illegible] — 5¼
14,248	5	5%	Do. Pref. 5%	5	4¾ — 5¼
5,000	62½	47/6	Nantyglo and Blaina Iron Works, Ltd., [illegible] Cum. Pref.	62½	79 — 82
73,000	10	5/-	N. Brit. Loco. Co., Ltd., 5% Cm. Pf.	10	12[illegible] — 12[illegible]
80,000	5		North Eastern Steel Co., Ltd.,		
£250,000	Stk	4½	4½ 1st Mt. Db. Stk., Red.	100	87 — 91
122,000	5	1/6	Pearson & Knowles Coal and Iron Co., Ltd., Ord., "B"	5	5½ — 5[illegible]
50,000	5	3/-	Do. 6% Cum. Pref. "A"	5	6 — 6¼
70,000	10	10/-	Pease & Partners, Ltd., Ord.	10	13¾ — 14[illegible]
£400,000	Stk	4%	Do. 4% Perp. Deb. Stock	100	[illegible] — 102
20,000	5	3/-	Peebles, Bruce & Co., Ltd., 6% Cm. P.	5	4⅝ — 5⅛
65,000	1	—	Pooley (Henry) & Son., Ltd., Ord	1	11/[illegible] — 12/[illegible]
13,000	5	—	Do. 5½% Cum. Pref. ..	5	4⅝ — 4[illegible]
230,000	1	—	Projectile Co. (1902), Ltd., Ord. ..	1	[illegible]
126,938	5	2/-	Rhymney Iron Co., Ltd. ..	5	2[illegible] — 2[illegible]
73,062	5	2/-	Do. New	5	1[illegible] — 2
£330,000	—	5	Do. 5% Mort. Deb., Red. ..	100	10[illegible] — 102
350,000	1	1/2½	Richardsons, Westgarth & Co., Ltd., Ord. 350,001—700,000 ..	1	[illegible] — 1
[illegible]	1	7½	Do. [illegible] Cum. Pref.	1	1 — 1⅛
£350,000	Stk	4½%	Do. 4½% Perp. Deb. Stock ..	100	100 — 102
35,000	10	12	Ruston, Proctor & Co., Ltd...	10	11 — 11[illegible]
270,000	1	6d.	Scott (Walter) Ltd., Ord.	1	[illegible]
300,000	1	7½d.	Do. 6% Cum. Pref.	1	1 — 1[illegible]
£300,000	Stk	4%	Do. 4% Perp. Deb. Stk	100	92 — 95
£115,300	100	5%	Shelton Iron, Steel and Coal Co., Ld. 1st Charge Debs., Red.	100	[illegible] — 97
£97,900	100	6	Do. 6% 2nd Mort. Debs. Red.	100	96 — 100
250,000	1	1/-	South Durham Steel & Iron, Ltd. Or.	1	1[illegible] — 1[illegible]
300,000	1	1/2½	Do. 6% Cum. Pref.	1	[illegible]
£300,000	Stk	4½	Do. 4½ Per. Deb. Stock	100	[illegible] — 96
[illegible]	10	—	Stephenson (Robert) & Co., Ltd., Or.	10	2[illegible]
25,000	10	5/6	Do. 5½ Cum. Pref.	10	[illegible]
£250,000	Stk	4	Do. 4% Perp. Deb. Stock	100	82 — [illegible]
[illegible],000	10	9/-	Stewarts & Lloyds, Ltd., Ord. ..	10	18[illegible] — 19[illegible]
55,000	10	6/-	Do. 6% Cum. Pref.	10	14½ — 15
634,732	1	6d.	Swan, Hunter & Wigham Richardson, Lim. Ord.	1	[illegible]
538,515	1	6d.	Do. 5% Cum. Pref.	1	[illegible] — 1[illegible]
£240,000	Stk	4½	Do. 4½ 1st Mort. Deb. Stk. Red.	100	98 — 101
300,000	1	6d.	Thames Iron Works, Shipbuilding & Engineering Co., Ltd., 5% Cum. Pf.	1	[illegible]
£200,000	100	4	Do. 4% Irredeem. 1st Mort. Deb.	100	82 — [illegible]
£148,500	1	7½d.	Thornycroft (John I.) & Co., Ltd. Or.	1	[illegible]
£100,000	1	7½d.	Do. [illegible] Cum. Pref.	1	[illegible]
10,000	10	7	[illegible] & Sons, Ltd. [illegible] Cum. Pf.	10	9 — [illegible]
$50,[illegible]	$100	[illegible]	United States Steel Corp. Com. Stk	$100	4[illegible] — 4[illegible]
$[illegible]	$100	[illegible]	Do. 7% Cum. Pref. Stock	$100	112 — 11[illegible]
$[illegible]	$1000	5	Do. 10-60 [illegible] Sk. F'd G. Bds.	$1000	102 — [illegible]
[illegible],000	1	1	Vickers, Sons & Maxim, Ltd. Ord.	1	2[illegible] — 2[illegible]
750,000	1	6d.	Do. [illegible] Non-Cum. Pref.	1	1[illegible] — 1[illegible]
£750,000	Stk	5	Do. 5% Non-Cum. Pref. Stock	100	121 — 124
£1,250,000	Stk	4	Do. 4% 1st Mort. Deb. Stk. Red.	100	104 — 10[illegible]
£1,000,000	100	4½	Do. 4½ 2nd Mort. Debs., Red.	100	104 — 106
250,000	1	1/2½	Weardale Steel, Coal & Coke, Ltd., Def. Ord.	1	1 — 1
500,000	1	7½d.	Do. 6% Cum. Pref. Ord.	1	1[illegible] — 1[illegible]*
£300,000	Stk	4%	Do. 4% Perpetual Deb. Stock	100	[illegible] — 9[illegible]
[illegible]	5	3	[illegible], Ord. ..	5	2 — [illegible]
[illegible]	5	[illegible]	Do. [illegible] Cum. Pref.	5	4 — 4[illegible]
£246,[illegible]	Stk	4	Do. 4% 1st Mort. Deb. Stk. Red.	100	[illegible] — 87
£150,000	Stk	4½	Yorkshire Iron & Coal Co., Ltd., 4½% 1st Mort. Deb. Stk. Red.	10	77 — 79

Stocks and Shares marked * are quoted ex-dividend.

II.—ELECTRICAL MANUFACTURING COMPANIES.

Present Amount Subscribed	Shares	Last Dividend.	Name	Paid up.	Closing Prices.
70,000	1	6d.	Alliance Elec. Co., Ltd. 5% Cum. Pf.	1	⅝— ⅞
125,000	1	7½d.	Aron Elec. Meter Ltd., 6% Cum. Pf.	1	⅛— ⅝
120,000	1	1/2⅝	Bell's Asbestos Co., Ltd.	1	1$\frac{1}{16}$—1$\frac{3}{16}$
£40,000	5	9d	British Aluminium Co. 7% Cum Pref.	5	5½— 6
£300,000	Stk	5%	Do 5% 1st Mort. Deb. Stk. Rd.	100	98—102
100,000	5	4/-	British Insulated & Helsby Cables Ltd., Ord. ..	5	7 — 7¼
100,000	5	3/-	Do. 6% Cum. Pref.	5	5¾— 6¼*
£500,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Rd.	100	103 —106
£200,000	Stk	4½%	British Thomson-Houston Co., Ltd., 4½% 1st Mort. Deb. Stk. Red. ..	100	98 —100
400,000	5	8/-	British Westinghouse Electric and Manufac. Co., Ltd., 8% Pref. ..	5	1¾— 2¼
£616,353	Stk	4%	Do. 4% Mort. Deb. Stk. Red...	100	77 — 82
105,731	2	2/-	Brush Elec. Enging. Co., Ltd., Ord..	2	⅜— ⅝
150,000	2	2 4½	Do. 6% Pref.	2	1¼— 1¾
£125,000	Stk	4½%	Do. 4½% Perp. 1st Deb. Stk...	100	99 —101
£125,000	Stk	4½%	Do. 4½% Perp. 2nd Deb. Stk.	100	82 — 84
35,000	5	5/-	Callender's Cable & Constn. Ltd. Ord.	5	11 — 12
40,000	5	2/6	Do. 5% Cum. Pref.	5	5⅜— 5⅞
£200,000	Stk	4½%	Do. 4½% 1st Mort. Deb Stk. Red.	100	108½—110½
85,000	3	1/6	Crompton & Co., Ltd...	3	1⅞ — 2⅛
£100,000	—	5%	Do. 5% 1st Mort. Reg. Debs.	100	95 —98%
52,000	5	10/-	Dick, Kerr & Co., Ltd., Ord. ..	5	8½ — 9
61,000	5	3/-	Do. 6% Cum. Pref.	5	5¾— 6¼
£300,000	Stk	4½%	Do. 4½% Deb. Stock, Red. ..	100	104 —106
233,334	1	6d.	Doulton & Co., Ltd., 5% Cum. Pref.	1	1⅛— 1⅜
£233,334	Stk	4%	Do. 1st Mort. 4% Iree. Deb. Stk.	100	106 —109
99,261	5	1/6	Edison and Swan United Electric Light, Ltd., "A" Shares Nos. 1-99,261	3	1½— 1⅝
17,139	5	2/6	Do. "A" Shares Nos. 01-017,139	5	2¼— 2¾
£341,023	Stk	4%	Do. 4% Deb. Stock Red. ..	100	86 — 88
£100,000	Stk	5%	Do. 5% Second Deb. Stk. Red.	100	93— 97
112,100	2	1/7½	Electric Construction Co. Ltd. ..	2	½— ¾
31,390	2	2/9⅜	Do. 7% Cumulative Pref. ..	2	2 — 2½
£200,000	Stk	4%	Do. 4% Perp. 1st Mt. Deb. Stk.	100	90 — 93*
10,248	10	7/6	Evered and Co., Ltd...	10	9 — 11
25,000	10	5/-	Gen. Elect. Co. (1900), Ltd., 5% Cum. Pref.	10	9½— 9⅞
£200,000	Stk	4%	Do. 4% 1st. Mt. Deb. Stk., Red.	100	96 —100
35,000	5	5/-	Henley's (W. T.) Telegraph Works Co., Ltd., Ord.	5	13 — 14
35,000	5	2/3	Do. 4½% Cum. Pref... ..	5	5¼— 5½
£50,000	Stk	4½%	Do. 4½% Mt. Deb. Stk. Red.	100	—
50,000	10	15/-	India Rubber, Gutta Percha & Telegraph Works Co., Ltd.,	10	18½ — 19½
£300,000	100	4%	Do. 1st Mort. Deb. Red. ..	100	99 —102
7,500	10	—	Parker, Thos. Ltd.	10	6½— 7
100,000	1	3%	Scott (Ernest) & Mountain, Ld., Ord.	1	17/3 —17/9
37,350	12	12/-	Telegraph Construction and Maintenance Co., Ltd.	12	34½ —36½
150,000	100	4%	Do. 4% Deb. Bonds	100	100—102

IV.—ELECTRIC LIGHTING AND POWER.

Present Amount Subscribed	Shares.	Last Dividend	Name	Paid up	Closing Prices
7,500	10	14/-	Bournemouth & Poole Elec. Sup. Co., Ltd. Ord. ..	10	12⅝— 12⅞
£70,000	Stk	4½%	Do. 4½% Deb. Stock Red ..	100	105 —107
14,000	5	3/6	Bromley (Kent) Elec Lt. & Pr. Co. Ld	5	5¼— 5¾
£50,000	Stk	4½%	Do. do. 4½% 1st Deb. Stk. Red.	100	102 —105
27,507	5	4/6	Brompton & Kensington Elec. Supply Co., Ltd. Ord. ..	5	8½— 9½
12,498	5	3/3	Do. 7% Cum. Pref. Shares..	5	8½— 9½
70,000	5	2/6	Charing Cross & Strand Elec. Sup. Corp., Ltd., Ord	5	5¾ — 6½
£350,000	Stk	4%	Do. do. 4% Deb. Stk. Red.	100	101 —103
41,436	5	2/3	Chelsea Elec. Sply. Co., Ltd., Ord.	5	5 — 6
£150,000	Stk	4½%	Do. do. 4½% Deb. Stk., Red	100	108 —110
70,595	10	7/-	City of London El. Lghtg. Co., Ld., O.	10	11 — 12
40,000	10	6/-	Do. 6% Cum. Pref... ..	10	13¾ — 14¼
£400,000	Stk	5%	Do 5% Deb. Stk., Red ..	100	122 —126
£300,000	Stk	4½%	Do. 4½% 2nd Deb. Stk., Red	100	100 — 102
40,000	10	4/-	County of London Elec Supply Co., Ltd., Ord.	10	8½ — 9½
30,000	10	6/-	Do. 6% Cum. Pref.	10	12½ — 13
£400,000	Stk	4½%	Do. 4½% Deb. Stk., Red. ..	100	109 —112
70,000	5	2/6	Edmundson's Elec. Cor. Ltd., Ord	5	5 —5½
70,000	5	3/-	Do. 6% Cum. Pref.	5	5 —5½
£300,000	Stk	4½%	Do. 4½% 1st Mort. Db. Stk. Reg	100	104 —106
10,000	5	2/-	Folkestone Elec. Supply Co., Ld., O	5	5¼ — 5¾
£50,000	Stk.	4½%	Do. 4½% 1st Deb. Stk., Red.	100	101 —104*
13,000	5	5/-	Hove Elec. Lighting Co., Ltd., Ord.	5	8¼ — 8¾
21,000	5	5/-	Kensington and Knightsbridge Electric Lighting Co., Ltd., Ord. ..	5	10½—11½
135,000	Stk	4%	Kensington and Knightsbridge Electric Lighting Co., Ltd., and the Notting Hill Electric Lighting Co., Ltd., 4% Deb. Stock, Red.	100	101—103
111,000	3	1/9¾	London Elec. Supply Corp., Ld., Ord.	3	1¾ —2¼
60,000	5	8/-	Do. 6% Pref.	5	4¾ — 5¼
£371,895	Stk	4%	Do. 4% 1st Mort. Db. Stk., Red.	100	98 —101

ELECTRIC LIGHTING AND POWER.—*Contd.*

Present Amount Subscribed	Shares.	Last Dividend	Name	Paid up.	Closing Prices
100,000	10	5/-	Metropolitan Elec. Sup. Co., Ld., Or.	10	8¾ — 9¼
76,121	5	2/3	Do. 4½% Cum. Pref.	5	5¼— 5¾
220,000	Stk	4½%	Do. 4½% 1st Mort. Db. Sk., Red.	100	107 —111
250,000	Stk	3½%	Do. 3½% Mort. Deb. Stk, Red.	100	95— 97
£250,000	—	4½%	Midland Elec. Corp. for Power Distribution Ld., 4½% 1st Mort. Deb.	100	100 —102%
10,852	10	8/-	Notting Hill Elec. Ltg. Co. Ltd. Ord.	10	13½— 14½
£59,000	100	4%	Do. 4% 1st Mort. Debs. ..	100	98 —100
16,500	5	2/6	Oxford Electric Co. Ltd, Ord. ..	5	6⅜ — 6⅞
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	99 —101
40,000	5	5/-	St. James' & Pall Mall Elec. Light Co., Ltd. Ord.	5	11¼ —12¼
20,000	5	3/6	Do. 7% Pref.	5	7 — 8
£150,000	Stk	3½%	Do. 3½% Deben. Stock, Red	100	97 — 99
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	76 — 80
65,000	5	4/-	South London Elec. Sup. Co., Ltd. O.	5	3 — 3½
100,000	1	—	South Metropolitan Elec Light & Power Co., Ltd. Ord.	1	¼ — ¾
50,000	1	8⅜d.	Do. 7% Cum. Pref.	1	1$\frac{1}{16}$ —1$\frac{3}{16}$
£100,000	Stk	4½%	Do. 4½% 1st Deb. Stock Red.	100	105 —108
50,000	5	2/6	Urban Electric Supply Co., Ltd., O.	5	4⅜ — 4⅞
30,000	5	2/6	Do. 5% Cum Pref.	5*	5 — 5¼
£200,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Red	100	104 —106
110,000	5	6/6	Westminster Elec. Supply Corp. Ltd., Ord.	5	10½—11½

VI.—SHIPPING COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend	Name	Paid up.	Closing Prices
32,500	10	5/6	Anchor Line (Henderson Bros.), Ltd., 5½% Cum. Pref.	10	9¼— 9¾
£325,000	Stk	4½%	Do. 4½% Red. 1st Mort. Deb. Stk.	100	100—102
£672,900	Stk	4½%	British & African Stm. Nav. (1900) Ltd., 4½% 1st Mort. Deb. Stk., Red.	100	98 —100
10,000	10	5/6	Bucknall Steamship Lines, Ltd., 5½% Cum. Pref.	10	6¼— 6¾
£600,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk.	100	—
£750,000	Stk	4½%	Clan Line Steamers, Ltd., 4½% Deb. Stk. Red. ..	100	97 — 99
60,000	20	16/-	Cunard Steam Ship Co., Ltd., Nos. 1-60,000..	20	14 — 14½
40,000	20	8/-	Do. Nos. 60,001-100,000	10	6½— 7
£464,430	Stk	4½%	Elder Dempster Shipping, Ltd., 4½% 1st Mort. Deb. Stk. ..	100	102—104
1,200,000	1	6d.	Furness, Withy & Co., Ltd., Ord...	1	1⅛ — 1⅜
25,328	7½	4/7	Gen. Steam Navigation Co., Ld., Ord.	7½	5¾ — 6¼
36,758	8	4/9½	Do. Non-Cum. 6% Pref.	8	8¾— 9¼*
£150,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	97 — 99
55,000	5	1/3	Houlder Line, Ltd., Ord.	5	1 — 2
40,000	5	2/9	Do. 5½% Cum. Pref.	5	2¾— 3¼
£200,000	Stk	4½%	Do. 4½% 1st Mt. Deb. Stk. Red.	100	83 — 86
141,500	10	5/-	Leyland (Fredk.), & Co., (1900), Ltd., 5% Cum. Pref. ..	10	5½— 6
20,349	10	5/-	Orient Stm. Nav. Co. Ltd., Pref Nos. 1-20,349 ..	10	7 — 7½
£103,160	Stk	4%	Do. 4% Deb. Stk., Red. ..	100	87 — 90
£1,160,000	Stk	5%	Peninsular and Oriental Steam Nav. Co, 5% Cum. Pref. ..	100	127 —130
£1,160,000	Stk	19%	Do. do Deferred ..	100	239 — 242
15,000	100	30/-	Royal Mail Steam Packet Co Ord..	60	53 — 54
39,075	5	2/6	Shaw, Savill & Albion, Ltd., 5% Cum. "A" Pref..	5	4¾— 5¼
39,075	5	2/6	Do "B" Ord...	5	3¾— 4¼
141,841	10	4/-	Union Castle Mail Steamship Co., Ltd., Ord..	10	8 — 8½
24,000	10	4/6	Do. 4½% Cum. Pref... ..	10	10½— 11
£1,008,894	Stk	4%	Do. 4% Debenture Stk., Red.	100	99 —101

RAILWAY CARRIAGE & WAGON COMPANIES.

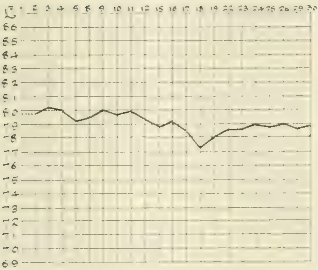
Present Amount Subscribed	Shares.	Last Dividend	Name.	Paid up.	Closing Prices
10,000	10	7/6	Birm. Railway-Car. & Wagon, L., 1-10,000	10	26 — 26½
8,739	10	3/-	Do. Second Issue 1-8,739....	4	9¾ —10
10,000	10	6/-	Do. Cum. Pref. 6% 1-10,000..	10	13¾—14¼
30,111	7	7/-	Gloucester Rail. Car & Wagon, Ld., A, 1-29,861 & 49,751-50,000	7	10⅝— 10⅞
44,889	7	3/6	Do. B, 29,862-49,750, 50,001-75,000	7	4$\frac{9}{16}$— 4$\frac{11}{16}$
14,567	10	1/3	Lancashire Wagon, Ord.	2	2¼— 2¾
4,150	10	5%	Do. do.	10	10⅜— 10⅞
784,808	1	9d.	Metropolitan Amalgamated Rail.-Carriage & Wagon, Ld., 1-784,808	1	44/6 —45/6
164,288	1	6d.	Do. Cum. A Pref. 5% 1-164,288	1	24/- —25/-
235,000	1	7½d.	Do. Cum. B Pref. 6% 1-235,000	1	28/- —29/-
20,000	20	20/-	Midland Rail.-Car & Wagon, Ld., 1-20,000	10	20¾— 21½

Stocks and Shares marked * are quoted ex-dividend.

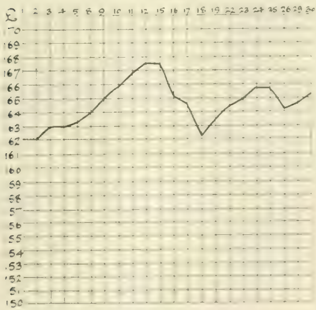
THE HOME METAL MARKET.

SHOWING DAILY FLUCTUATIONS FROM JANUARY 1ST, TO JANUARY 30TH, 1906.

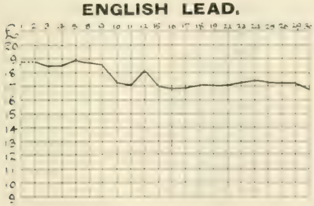
COPPER.



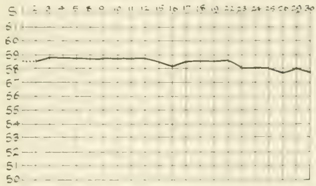
TIN.



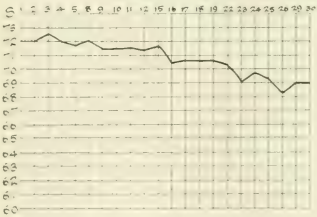
ENGLISH LEAD.



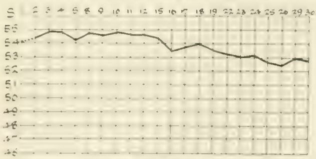
PIG IRON: SCOTCH.



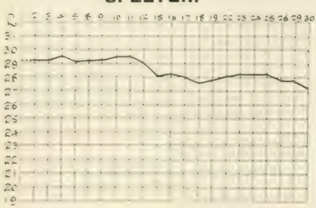
HEMATITE.



CLEVELAND.



SPELTER.



PRICES CURRENT OF COAL, IRON, STEEL, AND OTHER METALS.

MANUFACTURERS' AND MERCHANTS' QUOTATIONS.

MARKET REPORT.

Wednesday, January 31st, 1906.

PIG iron has been somewhat weaker on liquidation, and a good deal of the selling has been on account of tired holders. A factor making for lower prices is the steady increase in the warrant stock of Middlesborough iron, and it is stated that fresh furnaces are being put in blast. The outcome has been a relapse in the price of Cleveland to 52s. 4d., with Hematite quoted at 69s. Standard is quoted at 52s., and this lower range of quotations ought to prove attractive in the present healthy position of the iron and steel industries. Reports from the principal centres of the industry point to a continuance of the unprecedented consumption which has characterised the market for some time past. Some interesting figures are contained in the statement issued by Mr. Waterhouse dealing with the production and prices in the manufactured iron trade of the North of England for November and December, during which period the rise in price was the most notable for a considerable period. The net average rate improved to the extent of 3s. 0d. per ton on the previous two months. The figures which are issued by the secretaries of the Board of Conciliation and Arbitration and Darlington and Middlesbrough are worthy of study.

Copper shows some recovery from the recent depression, and the improvement has been accompanied by a disposition to reduce bear commitments. A careful review of the position does not reveal any change in the general situation, all offerings being well absorbed. The closing prices are £78 12s. 6d. cash, and £77 15s three months.

Tin has been good on strong Eastern advices, with bids reported up to £167 10s., Singapore c.i.f. London, but no sellers. All efforts to depress tin on the eve of the Banca sale failed, and the latest prices are £165 15s. cash, and £165 three months.

Spelter is weaker, G.O.B.'s being offered at £27 5s. Lead is also lower, and although at one time £17 was paid the price has slipped back to £16 10s. for soft foreign prompt. The coal market is in a very satisfactory condition, steams having been exceptionally firm.

IRON, STEEL, PIG-IRON, &c.

SCOTLAND.

Messrs. David Colville and Sons, Ltd., Dalzell Steel and Iron Works, Motherwell, N.B., quote as follows. **Prices delivered** in Glasgow or equal.

Steel:

	£	s.	d.
DALZELL STEEL Siemens' Steel Plates, Marine Boiler Quality	[illegible]	[illegible]	6
" " " Land " "	[illegible]	[illegible]	6
" Steel Bars, Boiler Quality	[illegible]	[illegible]	0
DALZELL STEEL Siemens' Steel Plates, Ship Quality Plates	[illegible]	[illegible]	6
" " Bars " " .	7	[illegible]	0
" " Angles.	[illegible]	[illegible]	0

Manufactured Iron:

	£	s.	d.
Bars—Dalzell	[illegible]	[illegible]	6
" Best..	[illegible]	[illegible]	6
" " Horseshoe	[illegible]	[illegible]	6
" Angle	[illegible]	[illegible]	6
" Best Angle.	[illegible]	[illegible]	6
" Best Best	[illegible]	[illegible]	6
" Extra Best	[illegible]	[illegible]	6

Usual terms and extras. Special rates for delivery in England and export. The above prices subject to alteration without notice.

Malleable Common Bars:

	£	s.	d.	
Dalzell, per ton	[illegible]	[illegible]	[illegible]	per cent.
Govan.	[illegible]	[illegible]	[illegible]	..
North British	[illegible]	[illegible]	[illegible]	..
Drumpellier	[illegible]	[illegible]	[illegible]	..
Waverley	[illegible]	[illegible]	[illegible]	..
Crown	[illegible]	[illegible]	[illegible]	..
Dundyvan.	[illegible]	[illegible]	[illegible]	..
Muirkirk	[illegible]	[illegible]	[illegible]	.
Rochsolloch	[illegible]	[illegible]	[illegible]	.
Phœnix..	[illegible]	[illegible]	[illegible]	.
Coatbridge	[illegible]	[illegible]	[illegible]	.
Coats	[illegible]	[illegible]	[illegible]	.
Angle Iron				.
Steel Plates, ship				..
" Boiler Plates				..
Rails				..
Railway Chairs				.

G.M.B. at Glasgow, No. 1, 61s.; No. 3 61s.

John Spencer (Coatbridge), Ltd., Phœnix Ironworks, Coatbridge, N.B., quote:—

	£	s.	d.
Bars—Phœnix	[illegible]	[illegible]	0
" Best	[illegible]	[illegible]	0
" Best Best	[illegible]	[illegible]	0
" Extra Best	[illegible]	[illegible]	0
" Best Horse Shoe	[illegible]	[illegible]	0
" Extra B.H.S.	[illegible]	[illegible]	0
" Extra Best Cable	[illegible]	[illegible]	0
" Rivet	[illegible]	[illegible]	0
" Best Scrap Rivet	[illegible]	[illegible]	0
Angles—Phœnix	[illegible]	5	0
" Best	[illegible]	[illegible]	0
" Extra Best	[illegible]	[illegible]	0
Gas Tube Hoops—Phœnix Best	[illegible]	[illegible]	0
Plates—Phœnix			
" Best Boiler	[illegible]	[illegible]	0
" Best Best Boiler	[illegible]	[illegible]	0
" Extra Best Boiler	10	0	0
Boiler Tube Strips—Phœnix	[illegible]	0	0

All per ton delivered f.o.s., Glasgow, Greenock, Grangemouth, Granton, Leith or Ardrossan. 5 per cent. discount cash monthly.

Messrs. R. Feldtmann and Co., of Glasgow, quote commission extra:—

Pig Iron:

	No. 1.	No. 3.
	£ s. d.	£ s. d.
Coltness, f.a.s. Glasgow	[illegible]	[illegible]
Gartsherrie	[illegible]	[illegible]
Summerlee	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Langloan	3 10 0	[illegible]
Calder	[illegible]	[illegible]
Clyde	[illegible]	[illegible]
Glengarnock, f.o.b. Ardrossan	[illegible]	[illegible]
Eglinton	[illegible]	[illegible]
Dalmellington, Ayr	[illegible]	[illegible]
Shotts, Leith	[illegible]	[illegible]

NORTH OF ENGLAND.

Messrs. W. Whitwell and Co., Ltd., Thornaby Ironworks, Stockton, quote as follows, at works:—

	£ s. d.
W W (crown) Bars	[illegible]
W W Best Bars	[illegible]
W W Best Best	[illegible]
W W Best Best Best	[illegible]
W W Best Sheet	[illegible]
Thornaby (crown)	[illegible]
Thornaby Best	[illegible]
Thornaby Best Best	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
W W Angle Iron	[illegible]
W W Best Angle Iron	[illegible]
[illegible]	[illegible]

Terms [illegible]

LANCASHIRE.

The Pearson and Knowles Coal and Iron Company, Ltd., Dallam and Bewsey Forges, Warrington, quote as follows:

		Iron.	Steel.
		£ s. d.	£ s. d.
(P&K)	Bars	[illegible]	[illegible]
(P&K)	Angles	[illegible]	[illegible]
(BW)	Tees	[illegible]	[illegible]
(crown)	Hoops	[illegible]	[illegible]
W.I.W.	Sheets	[illegible]	[illegible]

[illegible]

WORCESTERSHIRE.

Baldwins, Ltd. (with which is amalgamated Knight and Crowther, Ltd.), Wilden Works, near Stourport, quote:—

	Singles.	Doubles.
Black Sheets	£ s. d.	£ s. d.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

Patent Coated Sheets:

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Tinned Sheets:

Best Coke [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] for all [illegible]

At works.

Galvanized Corrugated Sheets:

[illegible]

Galvanised Working Up-Sheets:

[illegible]

STAFFORDSHIRE.

Shelton Iron, Steel, and Coal Co., Ltd. Stoke on-Trent, North Staffordshire, and 122, Cannon Street, London, quote:—

	£ s. d.
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

WALES.

Cordes (Dos Works), Ltd., of Newport, Mon., quote [illegible]

Discounts—

[illegible]

Messrs. Richard Thomas and Co., Ltd., of 33 and 35, Eastcheap, E.C. Works: South Wales, Burry, Lydney, Lydbrook, and Cwmbwrla.

Coke Tin-Plates [illegible]

Charcoal Tin-Plates [illegible]

BELGIUM.

C. L. Faulkner, Suffolk House, Laurence Pountney Hill, London, E.C., quotes:

Prices quoted are in £ stg. and per ton of 1,016 kos. (2,240 lb.) delivered free on board ANTWERP for approved quantities.

Steel:

		£	s.	d.	
Blooms	at	4	8	0	..
Billets	at	4	10	0	..
Sheet Bars	at	4	12	0	..

Finished Steel:

		£	s.	d.	
Bars	at	6	0	0	
Angles	at	6	2	0	
Tees	at	6	4	0	
Joists	at	5	5	0	
Fencing Standards	at	6	7	6	..
Shoeing Bars	at	6	5	0	
Tyre Bars	at	6	5	0	..
Half-round Bars	at	6	10	0	
Heavy Rails	at	6	0	0	..
Light Rails	at	6	0	0	..

Structural Steelwork. Prices on application.

METALS.

Messrs. French and Smith, 147, Leadenhall Street, and 11, Oldhall Street, Liverpool, quote:—

TIN.

Tin:

	£ s. d.		£ s. d.	
English Ingots, f.o.b., Dis. 1½% & 1%	166 10 0	to	167 0 0	per ton.
English Bars, f.o.b., Dis. 1½% & 1%	167 10 0	to	168 0 0	..
Straits G.M.B., cash, Warehouse, Net	165 0 0	to	165 2 6	..
Straits G.M.B., 3 months, Warehouse, Net	164 10 0	to	164 12 6	..
Australian Mt. Bischoff, Warehouse, Net	165 10 0	to	166 0 0	..

COPPER.

Copper:

	£ s. d.		£ s. d.	
Standard G.M.B., cash, Warehouse, Net	78 12 6	to	78 15 0	per ton.
Standard G.M.B., 3 months, Warehouse, Net	77 7 6	to	77 10 0	..
English Tough, Cake & Ingot, Warehouse, Net	84 0 0	to	84 10 0	..
English, Best Select, Warehouse, Net	84 0 0	to	84 10 0	..
English, Sheets and Sheathing, f.o.b., Dis. 2½%	92 0 0	to	93 0 0	..
English Sheets for India, f.o.b., Dis. 2½%	89 0 0	to	90 0 0	..
Electro, Warehouse, Net	86 5 0	to	86 10 0	..
Ore, ex ship	0 15 6	to	0 16 6	per unit.
Regulus, Matte and Precipitate, ex ship	0 16 6	to	0 17 0	..

YELLOW METAL.

Yellow Metal:

	£ s. d.	
Sheets and sheathing for India, f.o.b., Dis. 2½	0 0 7⅛	per lb.
Sheathing	0 0 7¾	..

SPELTER.

	£ s. d.		£ s. d.	
Silesian ordinary, Net	27 [illegible] 0	to	27 10 0	per ton.
Blende [illegible], Net	8 10 0	to	8 [illegible] 0	..
Calamine, Net	8 12 6	to	8 [illegible] 0	..

LEAD.

	£ s. d.		£ s. d.	
English Pig, Warehouse, Dis. 2½	16 12 6	to	16 15 0	per ton.
Spanish, [illegible] Dis. [illegible]	16 7 6	to	16 10 0	..
Lead Ore [illegible], Net	[illegible]	to	[illegible] 10 0	..

ANTIMONY.

	£ s. d.		£ s. d.	
Star Regulus [illegible] Dis. 2½	[illegible]	to	[illegible] 0 0	per ton
Ore, [illegible]	[illegible] 0	to	[illegible] 0 0	..
Crude, [illegible]	[illegible]	to	[illegible] 0 0	..

QUICKSILVER.

	£ s. d.	
Spanish, [illegible] Warehouse, Net	[illegible] 6	per flask.
Italian	[illegible]	

COAL.

LEICESTERSHIRE.

The Nailstone Colliery Company, Leicester, quote: Price per ton at Pit of 20 Cwt., with ½ Cwt. per ton for wastage.

Upper Main Seam:

	s.	d.
Main Coal	6	6
Best Hard Steam (hand picked, as used by the Railway Companies)	[illegible]	6
Best Hard Steam Cobbles (made through 6 in. mesh, free from slack)	6	6
Fine Slack	[illegible]	[illegible]

Terms, net cash on 10th of month following delivery.

DERBYSHIRE.

The Manners Colliery Co., Ltd., of Ilkeston, quote as follows per ton at pit:

Kilburn Coal:

	s.	d.
Best London Brights	9	[illegible]
Large Nuts (1½ to 3½)	[illegible]	0
Small Nuts (¾ to 1½)	6	0
Peas (½ to ¾)	[illegible]	0
Rough Slack	4	[illegible]
Slack	3	6
Smudge	2	0

Rutland Coal:

	s.	d.
Brights (4 to 8)	7	6
Large Nuts (2 to 4)	7	0
Slack	3	6
Hand-picked Hards	7	6
Hard Cobbles	6	3

The Clay Cross Company's Collieries, Clay Cross, near Chesterfield, quote:—

	per ton at pit s. d.
Best Main Coal	10 6
Best Silkstone	10 0
Best House Coal	8 6
Best House Nuts	8 0
Treble Screened Cobbles	7 9
Best Cobbles	7 3

NOTTINGHAMSHIRE.

The Digby Colliery Co., Ltd., near Nottingham, quote per ton at pit:—

Digby Coal:

STEAM.

	s.	d.
Best Hand-picked Hard	8	6
Steam Hard	7	[illegible]
Hard Nuts	6	6

Gedling Colliery.

HIGH HAZEL (or Ashless House Coal).

	s.	d.
London Brights, 4 to 8 in. cube	11	0
Bright Cobbles (Hand Picked)	10	[illegible]
Large Nuts, 2 to 4 in. cube	10	0
Small Nuts, 1 to 2 in. cube	6	[illegible]
Pea Nuts, ½ to 1 in. cube	[illegible]	0

STEAM TOP HARD.

	s.	d.
Best Hard	8	6
Hard Steam	[illegible]	[illegible]
Cobbles	[illegible]	[illegible]

CHEMICALS.

Messrs. S. W. Royse and Co., Albert Square, Manchester, quote:

		£ s. d.	
Acids, Oxalic		0 0 2¾	per lb.
Picric, Crystals		0 0 11	..
Tartaric	at Manchester	0 0 11	..
Acetate of Lime: Brown	at Manchester net	8 [illegible] [illegible]	per ton
Grey	..	11 1[illegible] 0	..
Alumina: Alum, Lump, loose		[illegible] 7 6	
.. .. in casks		[illegible] 10 0	
.. Ground, in bags		[illegible] 1[illegible] 6	
Sulphate of Alumina, 14%		4 1[illegible] 0	..
Ammonia: Carbonate		0 0 [illegible]	per lb.
Muriate Grey	f.o.b. Liverpool	24 1[illegible] 0	per ton
Sal ammoniac, Lump	1sts, delivered U.K.	1[illegible] 0 0	
.. .. ..	2nds, ..	40 0 0	..
Sulphate	f.o.b. Liverpool	12 11 [illegible]	..

		£ s. d.	
Arsenic: Best White Powder	net	10 0 0	per ton.
Bleaching Powder	..	4 10 0	..
Borax. British Refined Crystal	..	13 0 0	..
Coal Tar Products:			
Benzole, [illegible]	..	0 0 8½	per gal.
.. [illegible]	..	0 0 9	..
Carbolic Acid Crystals, 34-35° C.	..	0 0 6	per lb.
.. .. 39-40° C.	..	0 0 6¼	..
.. Liquid, 97-99	..	0 0 10	per gal.
.. Crude, 25% at 60° F. f.o.b.	..	0 1 10	..
Creosote, ordinary good liquid	..	0 0 1¼	..
Naphtha, Crude, [illegible] at 120° C.	..	0 0 4	..
.. Solvent [illegible] at 160° C. f.o.b.	..	0 1 1	..
.. [illegible] at 160° C.	..	0 1 1½	..
.. [illegible] at 190° C.	..	0 1 1½	
.. Rectified flash point over 73° F. f.o.b.	..	0 1 1½	..
.. Rectified flash point over 100° F. f.o.b.	..	0 1 2½	..
Napthalene all qualities			
Pitch [illegible] f.o.b. Manchester	..	1 11 0	per ton.
Copperas: Green in bulk	..	0 12 6	..
.. [illegible] barrels f.o.b. Liverpool	..	1 18 6	..
Cake	..	1 1 6	..
Copper: Sulphate	..	25 0 0	..
Cyanides: [illegible] maximum	f.o.b. net	0 0 8½	per lb.
Lead. Acetate (Sugar) White English	..	28 0 0	per ton.
.. .. .. Foreign c.i.f. U.K.		24 10 0	..
.. .. Grey		24 5 0	..
.. .. Brown at Manchester		20 15 0	..
Nitrate		27 0 0	..
Litharge, Flake		19 [illegible] 0	..
.. Powder		19 15 0	..
Red Lead, Genuine c.i.f. London less [illegible]		19 5 0	..
White .. Dry	..	20 0 0	..
Naphtha (Wood). Miscible, 60 o.p.		0 2 4	per gal.
Solvent		0 2 7	..
Potash: Bichromate delivered England		0 0 3	per lb.
Carbonate 90/92 c.i.f. Hull		16 15 0	per ton.
Caustic 7[illegible]	..	18 12 6	..
Chlorate	net	0 0 3¼	per lb.
Montreal in Store Liverpool		31 10 0	per ton.
Prussiate Yellow	net	0 0 4½	per lb.
Soda: Ash, Caustic 48% Ordinary	net	5 5 0	per ton.
.. .. .. Refined	..	6 5 0	..
.. Carbonated, 48%	..	[illegible] 10 0	..
.. [illegible] Ammonia Alkali	..	4 10 0	..
.. [illegible] Refined Caustic, [illegible]	..	6 10 0	..
Caustic, White, 7[illegible]	..	10 12 6	..
[illegible]	..	9 12 6	..
[illegible]	..	8 12 6	..
[illegible]	..	8 10 0	..
Crystals [illegible]		3 0 0	..
[illegible]		3 7 6	..
Acetate c.i.f. Hull net		16 15 0	..
Bicarbonate [illegible] kegs		6 1[illegible] 0	..
Bichromate [illegible] England		0 0 2½	per lb.
Chlorate	net	0 0 3¼	..
Nitrate [illegible] Liverpool	..	11 0 0	per ton.
Phosphate		[illegible] 0	..
Prussiate	net	0 0 3½	per lb.
Silicate [illegible]		4 1[illegible] 0	per ton.
Sulphate [illegible]		1 10 0	..
[illegible]		1 1[illegible]	..
Sulphur: Rec[illegible]		4 1[illegible]	..
Roll		[illegible]	..
Flowers		[illegible] 10 0	..
Zinc: Sulphate		[illegible]	
Shellac [illegible]		[illegible]	per cwt.

MINERALS.

Messrs. S. W. Royse and Co. quote:—

		£ s. d.	
Barytes [illegible]		[illegible]	per ton.
China Clay [illegible]		[illegible]	
Chrome Ore [illegible]		3 10 0	..
Manganese [illegible]		[illegible]	per unit
Ochre [illegible]		[illegible]	per ton.
Talc [illegible]		[illegible]	

Messrs. Henry Bath and Son quote:—

	£ s. d.		£ s. d.	
Copper, Ores of [illegible]	0 1[illegible] 3	to	0 16 3	per unit
Regulus, 4[illegible]	0 16 3	to	0 16 [illegible]	..
Precipitate [illegible]	0 16 4½	to	0 16 1[illegible]	..
Tin Ores, 70[illegible]	107 0 0	to	108 [illegible]	
Lead Ore, 70%			8 15 0	
Blende, 50%			8 [illegible] 6	
Calamine			8 6 [illegible]	
Antimony, Star Regulus	[illegible] 0 0	to	[illegible] 0 [illegible]	..
.. Ore [illegible]	1[illegible]	to	18 0 0	

Messrs. Barrington and Holt, Cartagena, quote:—

		s. d.	
Iron Ore:			
Ord [illegible]	f.o.b. Porman	7 8	per ton.
.. ..	Cartagena	8 0	
Special low phos.	Porman		
.. ..	Cartagena	8 [illegible]	..
Extra quality do.	..	8 6	
Special Iron Ore		nominal	
Specular [illegible] do.	..	11 0	..
S.P. Campanil Coast		9 6	..

TIMBER.

Messrs. Alfred Dobell and Co., Liverpool, quote for wholesale quantities on c.i.f., Liverpool terms:—

COLONIAL WOODS.

Timber.		£ s. d.		£ s. d.
Quebec Square White Pine	per cub. ft.	0 1 [illegible]	to	0 [illegible]
Quebec Waney Board Pine	..	0 2 8		[illegible]
St. John Pine, 18in. average	..	0 2 [illegible]		[illegible]
Lower Ports Pine		0 1 [illegible]		[illegible]
Quebec Red Pine		0 1 [illegible]		[illegible]
Quebec Oak, 1st quality		0 2 [illegible]		[illegible]
Quebec Oak, 2nd quality		0 1 6		[illegible]
Ash		0 1 6		[illegible]
Elm		0 [illegible]		[illegible]
Hickory		0 2 [illegible]		[illegible]
Quebec Birch		0 1 6		[illegible]
St. John Birch		0 1 6		[illegible]
Birch Planks		0 0 10		0 1 0
Spruce Spars		0 0 10		0 1 [illegible]
Deals.				
1st quality Quebec Pine	per std.	[illegible] 10 0	to	[illegible] 10 0
2nd do. do.		17 0 0		[illegible]
3rd do. do.		11 10 0		[illegible]
St. John Miramichi, etc., Spruce		7 15 0		[illegible]
Nova Scotia Spruce		7 12 6		[illegible]
Spruce Boards		6 1[illegible]		[illegible]

UNITED STATES, etc., WOODS.

Pitch Pine.		£ s. d.		£ s. d.
Hewn	per cub. ft.	0 1 6	to	[illegible] 0
Sawn		0 1 6		[illegible] 0
Planks, Stowage		[illegible] 1 [illegible]		[illegible]
Boards, Prime	per std.	1[illegible] 10 [illegible]		18 0 0
Oak Timber	per cub. ft.	[illegible] 6		[illegible]
Oak Planks		0 [illegible]		[illegible]
East India Teak	per load	[illegible] 0		[illegible]
Greenheart		[illegible]		[illegible]

EUROPEAN WOODS.

Timber.				
[illegible]	per cub. ft.	[illegible]		[illegible]
Swedish		[illegible]		[illegible]
Norway Spars				
Deals.				
[illegible]		[illegible]		[illegible]

Openings for Trade Abroad.

Mexico.

A contract has been entered into with Señor Juan de la Fuente Parres for an appropriation of water from the River Trinidad de Jaltepec, for the purposes of irrigation and the production of motive power.

Denmark.

A Swedish report from Copenhagen states that there would be in Denmark a market for acetylene gas plant and lighting apparatus. It is stated that in spite of high import duties a firm in the South of Sweden has found a very good sale of these articles in Denmark in recent years.

Norway.

A notification has been received by the Commercial Intelligence Branch of the Board of Trade from the Acting Consul General at Christiania to the effect that tenders will be received by the Norwegian State Telegraph Department up to noon on February 10th for the supply of insulators, hooks, telephone wire and steel cables.

Bulgaria.

According to the Bulletin Commercial tenders will be received at the offices of the Finance Administration of the district of Sophia for the supply of (1) iron pipes, estimated cost £[illegible]; (2) lubricating oil, estimated cost £2,[illegible]; and (3) cotton waste, estimated cost £442, all for the use of the Bulgarian State Railways. Particulars can be obtained from the above-mentioned offices.

India.

The Pioneer states that the Secretary of State has approved the three years' programme of railway construction and maintenance in India involving an expenditure of 10 million sterling annually, half of which will be on new lines. The sanction for [illegible] is definite and that for the two following years provisional. According to the same newspaper, the Government of Eastern Bengal and Assam notify that a survey will shortly be made for a line of railway from Narainganj to Lenga Bazaar in Assam, passing through the districts of Mymensingh, Sylhet, and the Khasi Hills. This line is apparently part of a scheme to connect Dacca with Shillong and so give direct communication between the two headquarters of the new province. At present Shillong can only be reached by rail *via* Narainganj, Chandpur, and Gauhati, or by steamer from Jagannathganj to Gauhati and thence by tonga to Shillong.

Argentina.

A recent issue of the Review of the River Plate announces that the Province of Buenos Ayres has granted a concession for a light railway from Rosello to Arrecifes, to Messrs. V. Musante and Sons, Gil. The maximum cost is not to exceed $[illegible] per kilometre. In the same journal it is stated that the negotiations between the Province of Buenos Ayres and a firm of bankers represented by Messrs. Bemberg and Co., for a network of railways, are now nearly complete. The line will start from La Plata and go to meridian five, a distance of about [illegible] kilometres.

Belgium.

Tenders are invited by the Belgium State Railways for the supply of various manufactures of iron, steel, copper, etc. The adjudication of one series of lots will take place on 7th February at the Bourse, Brussels, and of the other series at the same place on February 21st. Tenders will also be invited shortly by the State Railways for the installation of electric light in the station at Esschen and for the supply of apparatus for the electric lighting of trains. The conditions of the contract may be obtained on application to the "Bureau des Adjudications, Musée Commercial, rue des Augustins, Brussels."

Brazil.

The expenditure of £50,250 has been sanctioned for the widening of the gauge of the Central Railway of Brazil between Taubaté and Sao Paulo. The plans and estimates submitted by the "Compagnie Auxiliaire de Chemins de Fer au Brésil" for the construction of the first 25 kilometres of a line to connect Neustadt with the Rio Grande do Sul Railway have been approved. The cost of this work is estimated at £111,002. Tenders are invited for supplying the Central Railway of Brazil with the material necessary for a compressed air installation, including a compressor, a lift and other accessories. Tenders have to be presented on February 23rd, at the offices of the Company in Rio de Janeiro, where specifications and drawings may be inspected.

Selected Patents.

NEW PATENTS APPLIED FOR.

ENGINEERING—CIVIL, MECHANICAL, ETC.

Belting.—T. Strickland, Sheffield. Improvements in [illegible] driving belts [illegible]

Belting.—[illegible] Halifax. Improvements in or relating to [illegible]

Belting.—[illegible] Improvements in machinery driving belts. 1,447.

Belting.—[illegible] Manchester. Improvements in driving belting. [illegible]

Boilers.—S. Rothwell and J. [illegible] London. Improvements in or relating to the construction of [illegible]

Boilers.—F. D. Domville, Liverpool. Improvements in [illegible]

Boilers.—[illegible] Improvements in [illegible]

Breakwaters.—[illegible] London. Improvements in the construction of breakwaters, piers and other structures [illegible] the waves. [illegible]

[illegible] A. G. Brown, Manchester. An improved [illegible]

[illegible] Newton, London. Improvements [illegible]

Cranes.—[illegible] Pitt, Ltd., and H. A. R[illegible] London. Improvements in or relating to cranes. [illegible]

Crank Shafts.—E. C. R. Marks, London. Improvements [illegible] crank shafts. [illegible]

Drilling Machines.—[illegible] Robinson and Co., Ltd. and [illegible] London. An improved [illegible] drilling machine. [illegible]

Elevators.—[illegible] Elevator Company, Ltd., London. Improvements in elevators or hoists. [illegible]

Engines.—[illegible] London. Improvements [illegible] engines. 1,575.

Engines.—[illegible] London. Improvements [illegible]

Engines.—[illegible] Brooke, London. [illegible]

Engines.—[illegible] London. Improvements for regulating the supply of fuel to [illegible]

Engines.—[illegible] Ltd., [illegible] London. An improved [illegible]

Engines.—[illegible] London. Improvements [illegible]

Engines.—[illegible] London. [illegible]

Engines.—[illegible] Improvements [illegible]

Engines.—[illegible] Improvements [illegible]

Engines.—[illegible] Schulz, Liverpool. Improvements [illegible] connected with forward and [illegible]

Engines, Elastic Fluid Turbines.—The Warwick Machinery Company, Ltd., and [illegible] London. Improvements in and relating to nozzles for elastic fluid turbines. [illegible]

Fans.—D. Hall and J. H. Kay, Manchester.—An improvement in or connected with fans, blowers, and the like. [illegible]

Feed-water Heaters.—[illegible] Manchester. Improved construction of feed-water heater. [illegible]

Fluid Pressure Motors.—Belliss and Morcom, Ltd., and McGregor, London. Improved means of control of fluid pressure motors. [illegible]

Furnaces.—G. [illegible] London. Improvements in or relating to furnaces. [illegible]

Furnaces.—[illegible] Manchester. Improvements in apparatus for feeding fuel to furnaces of steam boilers. [illegible]

Furnaces.—[illegible] Hill, London. Improvements in [illegible] apparatus for steam generators or like furnaces. [illegible]

Furnaces.—J. L. Garsed, Halifax. Improvements in or relating to mechanically operated grates or for [illegible] furnaces. [illegible]

Gas Producers.—[illegible] Dawson, London. Improvements in gas generators. 1,417.

Gas Producers.—J. [illegible] London. Improvements relating to gas producers. 1,315.

Gas Producers.—[illegible] und Maschinenbauanstalt G. Luther Akt. Ges., Liverpool. Improvements in and relating to gas producers. [illegible]

Gas Producers.—H. [illegible] Smith, London. Improvements in or relating to producer-gas plants. [illegible]

Gas Producers.—H. H. Lake, London. Improvements in gas producers. [illegible]

Gauge Glass Cleaner.—[illegible] H. Newton and [illegible] Wheatley, [illegible] A gauge glass cleaner. [illegible]

Haulage Clips.—J. W. Smallman, Nuneaton. Improvements in haulage clips. [illegible]

Hoisting.—[illegible] Y. Johnson, London. Improvements in hoisting and dumping apparatus and buckets [illegible]

Hoisting Apparatus.—[illegible] H. Brocklebank, London. Improvements in elevators for hoisting automatically counting and discharging baskets, boxes or other small packages. [illegible]

Liquid Fuel.—[illegible] Boilers, Birmingham. Improvements in [illegible] liquid fuel. [illegible]

Locomotives.—[illegible] Manchester. A new or improved [illegible] for arresting the passage [illegible] locomotive or other chimneys. [illegible]

Locomotives.—[illegible] Chancery-lane, London. An improved method for preventing the formation of [illegible] in locomotive furnaces. 1,274.

[illegible] H. [illegible] Birmingham. Improvements in and relating to [illegible] for use in [illegible] of machinery and the like.

Measuring.—[illegible] London. Improved optical [illegible] with measuring instruments. [illegible]

P[illegible] W. [illegible] Improvements in [illegible]

P[illegible] J. [illegible] Sunderland. A new [illegible]

PIPE JOINTS.—J. H. Mann and Mann's Patent Steam Cart and Wagon Company, Ltd., Leeds. An improvement in or relating to pipe joints. 1,530.

PILES.—E. Hughes, London. Improvements in or or relating to wood, concrete or metal piles. 1,213.

PLANING MACHINES.—Luke and Spencer, Ltd., and Turner, Manchester. New or improved traversing mechanism for the tables of planing and shaping machines and the like. 1,044.

PUMPS.—T. THORP, Manchester. Improvements in or relating to air vessels for pumps. 1,141.

RIVETS.—T. J. J. Wasley, London. A method of reinforcing rivets to enable them the better to resist the shearing stresses to which they are subjected in riveted structures. 1,089.

SEPARATING DUST.—S. COURTNEY, London.—Improvements in or relating to means for separating dust from air. 1,515.

SHAFT COUPLINGS.—J. Richter, London. Improvements in or relating to shaft couplings and the like. 1,117.

SUPERHEATERS.—T. Sugden, London. Improvements relating to steam superheaters for Lancashire and Cornish boilers. 1,277.

TAR EXTRACTION.—W. Blakeley, Dewsbury. Tar extractor for the extraction of tar from all kinds of compound gases. 1,257.

TIPPING CARTS.—W. L. Denton, Surrey. Improvements in or relating to tipping carts or wagons. 1,427.

TRANSFERRING SHIPS.—B. Schwarze, London.—Improvements in and connected with apparatus for transferring ships, boats and the like vessels from one waterway to another. 1,197.

VALVES.—E. H. E. BULWER, London. Improvements in lift or screw-down valves. 1,212.

VALVES.—J. E. BURRELL, London.—Improvements in pneumatic apparatus for actuating cocks or valves controlling the supply of gas or other fluid. 1,074.

VALVES.—W. H. Robinson, London. Improvements in valves. 1,495.

VALVE GEAR.—C. Kassubek, London.—Improvements in and relating to valve-gear for engines. 1,466.

WEIGHING MACHINES.—F. C. Symonds, London. Improvements in and relating to dials and scales for weighing machines. 1,081.

ELECTRICAL.

ACCUMULATORS.—M. Wilderman, London. Improvements relating to accumulators. 1,509.

BATTERIES.—A. P. Strohmenger, London. Improvements in or relating to secondary batteries. 1,396.

BATTERIES.—M. Wilderman, London. Improvements relating to electric batteries. 1,065.

BATTERIES.—W. H. Fellows, E. T. Pickup, and W. Tee, London. Improvements in or connected with electric secondary batteries. 1,576.

BATTERY TESTING.—H. Oppenheimer, London.—Improvements in and connected with battery testing apparatus in pocket size. 1,151.

BRUSH HOLDERS.—J. T. Westwood and W. L. Jones, London. Improvements in or relating to brush holders for dynamo-electric machines. 1,541.

CABLES.—J. E. Kingsbury, London.—Improvements in electric cables. 1,389.

COUPLINGS.—J. Nevset, London.—Improvements relating to electric couplings. 1,304.

FURNACES.—G. Gin, Birmingham. Improvements in or relating to electric furnaces. 1,010.

INSULATORS.—H. A. Dupré, London. Improvements in or relating to insulators for the conductor or "live" rails of electric railways and the like. 1,464.

LEAKAGE DISCHARGER.—H. M. Anning, London. A new or improved electrical leakage discharger and indicator for use on electric tramcars and the like. 1,114.

LIGHTING.—M. Fortuny, London.—Improvements in arc lamps. 1,410.

LIGHTING.—The British Thomson-Houston Company, Ltd., and E. J. Murphy, London. Improvements in and relating to electric arc lamps. 1,3[illegible].

LIGHTING.—J. W. Blakey, Bradford. Improvements in anti-vibrating devices for incandescent lighting. 1,140.

LIGHTING.—The British Thomson Houston Company, Ltd. and E. J. Murphy, London.—Improvements in and relating to electric arc lamps. 1,3[illegible].

METERS.—O. T. Blathy, London. Improvements in or relating to electricity meters. 1,487.

METERS.—The British Thomson-Houston Company, Ltd., and A. J. Martin, London. Improvements in and relating to electric meters. 1,115.

MEASURING CURRENTS.—R. Arno, London.—Improvements in and relating to the indication measuring and recording of electric currents. 1,221.

MOTORS.—The Rhodes Electrical Manufacturing Company, Ltd., and F. Creedy, London. Improvements relating to electric motors working with single-phase alternating currents. 1,097.

MOTORS.—W. M. Bradshaw, London. Improvements in alternating current electric motors.

OVERHEATING.—The Hon. C. A. Parsons, London. Improved means for preventing overheating of electrical machinery. 1,068.

SPARK GAP DEVICES.—The British Thomson-Houston Company, Ltd., London.—Improvements in and relating to electric safety spark gap devices. 1,300.

SWITCHES.—Veritys, Ltd. and A. Edgar Gott, Birmingham. Improvements in certain parts of electric switches. 1,242.

TARGET.—G. Hunter, London. Improved electrically indicating target. 1,218.

TIME INDICATOR.—G. Pattison, Leytonstone. A combination apparatus worked in conjunction with any time indicator for the purpose of calling attention electrically and automatically at any desired time at a distance from the said time indicator. 1409.

TROLLEY WIRE SUPPORTS.—F. Morris, London. Improvements in ears or supports for overhead trolley wires. 1,453

VAPOUR ELECTRIC APPARATUS.—The British Thomson-Houston Company, Ltd., London.—Improvements in and relating to vapour electric apparatus. 1,110.

WELDING.—O. Küppers, London. Improvements in or relating to the electrical welding of chains and the like. 1,289.

SHIPBUILDING, ETC.

BUOYS.—J. W. Edmundson, Dublin. Improvements in illuminating buoys and beacons. 1,127.

DISCHARGING VESSELS.—A. Holland, Northwich. A machine for discharging sea-going vessels, barges, and warehouses with cargo loose without any labour. 1,336.

PROPELLERS.—E. W. N. Nevill, Derby. A ship propeller. 1,227.

PROPELLERS.—F. W. Schroeder, London. Improved method of propelling vessels and apparatus therefor. 1,372.

PROPELLERS.—A. Hector, London. Improvements in propellers. 1,384.

PROPELLERS.—W. J. Bennett, Surrey. Improvements in ships' propellers. 1,402.

RAISING VESSELS.—J. E. Hewson, Hull. Improved means for preventing the sinking of vessels, and for raising sunken vessels. 1,035.

STEERING.—A. J. van Stockum, London. Improved apparatus for steering torpedoes and submarine boats. 1,47[illegible].

SUBMARINES.—A. Hector, London. Improvements in submarine vessels. 1,3[illegible].

TELEGRAPHIC APPARATUS.—Chadburn's (Ship) Telegraph Company, Ltd., and A. J. Grant, Liverpool. Improvements in ships' or analogous mechanical telegraphic apparatus. 1,252.

VENTILATION.—W. F. McIntosh and D. Allan, Glasgow. Improvements in and relating to the ventilation of the holds of vessels. 1,2[illegible].

WARP GUIDE.—W. H. Banks and W. R. Banks, Hull. An improved warp guide particularly for use on steam fishing vessels. 1,545.

MINING.

CAGES.—E. Nebel, London. An improvement relating to mine cages. 1,[illegible].

CAGES.—J. A. C. Robinson, Sheffield. Improvements in safety suspending or retaining apparatus for miner's pit cages, elevators and the like. 1,375.

EXPLOSIVES.—G. Grolet, London. Improvements relating to the manufacture of safety explosives. 1,573.

LAMPS.—R. O. Best, A. E. Best, and M. Best, London. Improvements in or connected with miner's safety and other enclosed portable lamps. 1,54[illegible].

IRON AND STEEL—METALLURGICAL.

BALL MILLS.—M. F. Abbé, London. Improvements in tubular ball mills. 1,323.

BALL MILLS.—C. Gieseeke, Liverpool. Improvements in and relating to ball mills. 1,[illegible].

BLAST FURNACES.—W. Kennedy, London. Improvements in apparatus for charging blast furnaces. 1,180.

BLOW PIPES.—F. A. A. Evans, London. Improvements in blow-pipe burners. 1,374.

BLOW PIPES.—V. F. Hein, London. Improvements in blowpipes and the like. 1,3[illegible].

CHARGING APPARATUS.—A. L. J. [illegible], London. Improvements in method of charging retorts, muffles, furnaces and the like and in apparatus therefor. 1,[illegible].

COPPER.—S. O. Cowper-Coles, London. Improvements in the electrolytic manufacture of copper wire strip or the like. 1,57[illegible].

COPPER.—R. [illegible], London.—Depuration of copper sulphate, contaminated with salts of iron and the consequent direct extraction of the sulphate of copper from ores. 1,299.

FURNACE GLOVES.—O. Stuart, Liverpool. Improvements in gloves for the use of furnacemen and others. 1,567.

IRON.—J. Wetter, London. Improvements in the manufacture of black oxide of iron. 1,0[illegible].

SILICON.—W. H. Cole, Liverpool. Improvements in the production of compounds of silicon. 1,52[illegible].

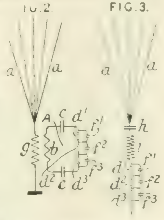
SILVER.—F. R. Power, London. A method for the production of fine or nearly fine silver from chloride of silver in fusion with chlorides of other metals. 1,[illegible].

SLAG.—F. Bennaman, London. Improved process for obtaining a slag. 1,[illegible].

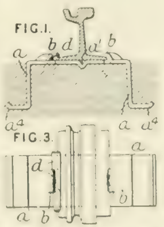
STEEL.—F. Andre, London. A new or improved method of and apparatus for manufacturing steel. 1,35[illegible].

Abridged Specifications.

W. P. Thompson, Liverpool.—(Ges. für Drahtlose Telegraphie m. b. H.; 3, Lindenstrasse, Berlin.)—2[illegible].—Relates to wireless telegraphy. In transmitting-apparatus for wireless telegraphy, the capacity of the closed exciting or oscillating circuit A, fig. 2, is diminished to an amount not greater than four times that of the earthed aerial conductor or radiating circuit *a*, in order to reduce the damping in the oscillating circuit. This diminution of capacity necessitating the employment of a higher self-induction and potential, and therefore of a longer spark gap which is preferably divided into a number of small gaps [illegible], each shunted by a small condenser, self-induction coil, or high ohmic resistance [illegible], in order to distribute the potential uniformly between the gaps as described in Specification No. [illegible], A.D. 19[illegible]. In one arrangement, fig. 2, the secondary *g* of a transformer is in the radiating circuit, and the primary *b* lies in the oscillating circuit, which also containing condensers *c*, to the circuit A may be conductively connected to the radiating circuit by joining one of the plates of each of the condensers *c* to the aerial conductors the coil *b* being omitted and the coil *g* playing the part of a choking-coil. The invention is shown in fig. 3 applied to a transmitter without an exciting-circuit, the capacity of which is reduced by the introduction of a condenser *h* into the aerial conductor *a*, and, in order to maintain the wave lengths of the system at their original values, a self-induction coil *i* is also inserted. In either example, a single aerial conductor or spark-gap may be employed.



A. Macleod-Carey, 2, Woodlands Terrace, Middlesbrough-on-Tees, Yorkshire.—[illegible].—Relates to chairs and rail joints and comprises means for anchoring and securing flat-bottomed rails in the permanent way of railways and tramways. An elastic support is formed for the foot or bottom flange of the rail by producing an anchor chair in the form of an inverted U shaped plate *a* by rolling or pressing operations. Clips [illegible] are formed in this plate by punching and the rail is secured in these by tapered wedges or keys *d* which may have split ends to prevent displacement. The lips may be strengthened by being bowed or otherwise formed as shown, a stiffening rib packed with wood or the like may be made in the bridge part of the plate and [illegible] may be employed to afford a good anchorage in the concrete or ballast. At the joints the anchor chair may be of increased width and formed with two or three pairs of clips.



NEW PUBLICATIONS.

"WIRELESS TELEGRAPHY AND TELEPHONY."

By Professor Domenico Mazzotto translated from the original Italian by S. R. Bottone. With 253 illustrations. Whittaker and Co. 6s. net.

Mr. S. R. Bottone has done a good service in rendering into English, Professor Mazzotto's admirable treatise on radio-telegraphy. The author has accomplished his task in a manner eminently satisfactory, and no essential facts or theories connected with the subject have been passed unnoticed. The object of the work is to set forth the principles on which the new system of signalling is founded, and to describe the instruments required in order to carry it into effect. The disposition of the apparatus in the wireless-telegraphy stations also receives attention. The writer gives a succinct record of the progress realised by the different inventors who have devised special systems of radio-telegraphy; he also traces chronologically the advances which have been made in radio-telegraphy signalling from Marconi's first experiments in Italy to the recent results of trans-Atlantic radiophony. The largest amount of space is, of course, allotted to the electric wave system, but before dealing with this section of the subject, consideration is given to conduction systems, induction systems, radiophonic systems and the ultra-violet and infra-red ray system. A chapter of unusual interest is that on wireless telephony; here are described the various systems designed and experimented upon by Preece and Gavey, Ducretet and Maiche, de Forest, Pansa, Collins, and Londardi. The book is profusely illustrated with diagrams.

"THE ROYAL NAVY LIST."

And Naval Recorder; a book of reference relating to the personnel of the Navy, both active and retired, and the ships of the fleet, together with a narrative of contemporary naval events and a naval bibliography. Published quarterly. Witherby and Co. 10s.

In the January issue of this publication attention is called to the fact that the Naval Recorder, the supplement of the Royal Navy List, has now entered upon its second year of existence. It is obvious that considerable pains have been taken to render the additional matter permanently useful. A chronological list of notable naval events has been compiled by a well-known naval historian, and there have been added such tables and records as will make the book of more value to the service. These include the list of Commanders-in-Chief at Home and Foreign stations since 1878, and a comparative table of the major headings of the Navy Estimates for the same period. Another interesting feature in the bibliography of naval literature which is classified according to dates and subjects.

"PRACTICAL DYNAMO AMD MOTOR CONSTRUCTION."

By Alfred W. Marshall, M.I.Mech.E. Percival Marshall and Co. 1s. net.

The latest addition to this firm's series of Practical Manuals deals with the constructive details and work shop methods used in building small dynamos and motors. The work, which is well illustrated, is one that will readily commend itself to beginners.

CIRCULARS AND PAMPHLETS RECEIVED.

Beanland, Perkin and Co., Leeds.—A list of flexible back hack saw blades and metal band saws.

Thomas Piggott and Co., Ltd., Birmingham.—The firm's latest circular gives a review in brief of their business in welded pipes for gas, water, steam, air, and sewage.

Richardsons, Westgarth and Co., Ltd., Hartlepool.—An illustrated pamphlet dealing with the electric driving of ring-spinning frames, on the system of Messrs. Brown, Boveri and Co.

Mavor and Coulson, Ltd., Mile End, Glasgow.—The diagram accompanying card calendar for January illustrates diagrametrically the progress of the "Pick-Quick" coal cutter.

The Brush Budget, for December, records in an interesting way, the progress of the Brush Electrical Engineering Company, Ltd. The central pages give a pictorial view of the "birth" of a tramcar.

R. J. Hall and Co., 39, Victoria Street, S.W.—The firm's monthly Bargain Book has many features of interest for the drawing office. The number under consideration has an instructive article on "Miniature Rifle Ranges."

The General Electric Company, Ltd., 71, Queen Victoria Street, London, E.C.—Pamphlet No. [illegible] illustrates and describes a selection of electric fittings, including railway electric bell coupling, and their pedestal main cut-outs.

The Valor Company, Ltd., Aston Cross, Birmingham.—An attractive pamphlet printed in red and black, and fully illustrated, is devoted to the firm's "New Era" petrol fire extinguisher, as described some time ago in PAGE'S WEEKLY.

Mechan and Sons, Ltd., Glasgow.—Illustrated pamphlets on the Watkinson steam superheater, steam dryers for extracting water and grit from high pressure steam, and oil separators for the removal of oil and grease from exhaust steam.

The Atlas Metal and Alloys Company, Ltd., 52, Queen Victoria Street, London, E.C.—A sheet of drawings and illustrations regarding the application of anti-friction metal to various classes of engine bearings which many of our readers will doubtless find useful to hang up in their casting shops.

The British Thomson-Houston Company, Ltd., Rugby.—The latest publications to be added to the firm's file are concerned with the B.T.H. Meridian lamp which is designed to fill the gap between the ordinary incandescent lamp and the arc lamp, and their mercury arc rectifier which is a simple device especially adapted for use in charging electric automobiles in private garages and for operating small continuous current machinery.

Electromotors, Limited, Openshaw, Manchester.—The firm's most recent catalogue describes and illustrates a wide range of standard motors and dynamos, including semi-enclosed, enclosed ventilated, totally enclosed crane motors, lift and hoist motors, worm and spur gear sets, variable speed motors and many other specialities. An attractive novelty is the firm's "Motorgraphic," an ingenious apparatus in cardboard, by which one may determine the necessary size of motor for any given conditions of horse power and speed.

PAGE'S WEEKLY Miscellaneous

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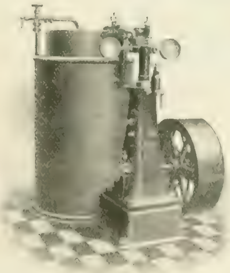

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PAGE'S WEEKLY — Engines, &c.

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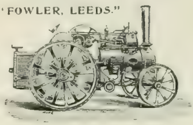

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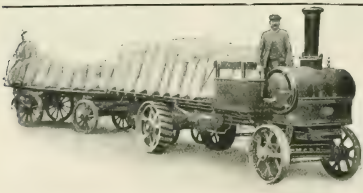

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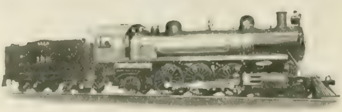

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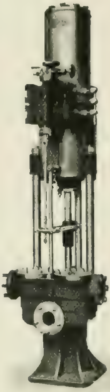
PAGE'S WEEKLY — Oil Engines, &c.

PAGE'S WEEKLY — Miscellaneous

PAGE'S WEEKLY — Pumps, &c.



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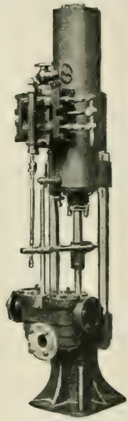

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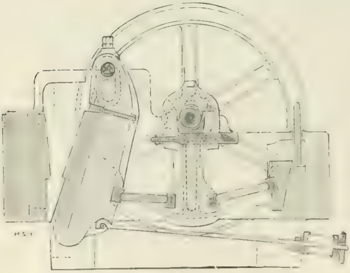

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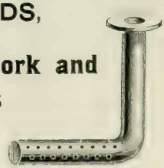
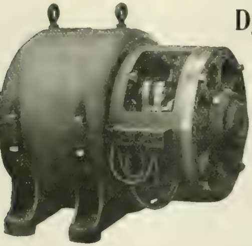
PAGE'S WEEKLY — Iron and Steel



PAGE'S WEEKLY Electrical Apparatus



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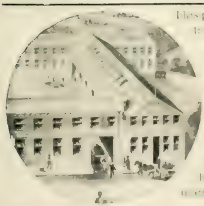

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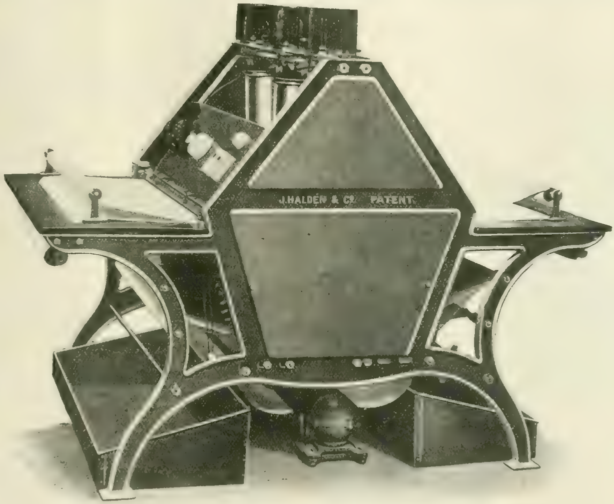
PAGE'S WEEKLY Engineers' Appliances



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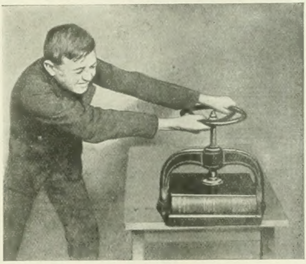

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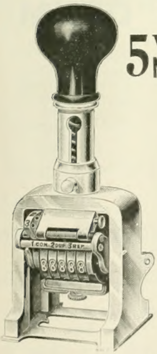

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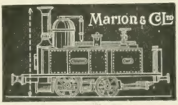

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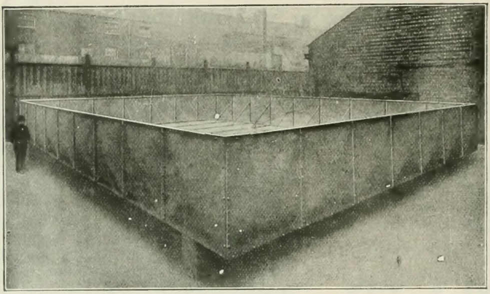

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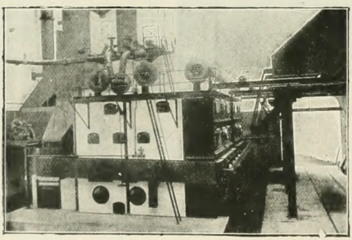

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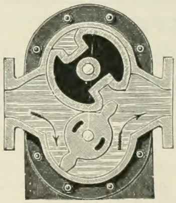

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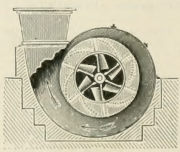

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